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THE

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1899

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CABLE CAPACITIES.

THE paper by Mr. J. Elton Young on the capacity measurement of long cables, read before the Institution of Electrical Engineers on April 27th, is without doubt of great interest and practical utility, and helps in no small degree to further elucidate an intricate problem which has exercised the minds of some of our leading electricians.

The advancement made in localising faults has of late years been well sustained, and, as Mr. Young justly observes, must not be gauged merely by the results appearing in the *Proceedings* of the Institution. Much patient and valuable work is being done by practical electricians in charge of our cable ships and stations abroad in perfecting methods of testing, and we would gladly see them more frequently contributing such well thought-out papers that others may benefit by their successes.

Among electrical problems the precise determination of the capacity of very long submarine cables certainly offers exceptional difficulties, arising from the fact that the measured result varies with the time of charging, and the difference between the rates of electrical absorption of the dielectric of the cable and of the condenser with which its capacity is compared. The question of absorption in the cable and condenser, which under prolonged charging may increase the condenser capacity by as much as 5 per cent., becomes more involved still, inasmuch as absorption is found to vary in degree with temperature and the specific inductive capacity of the dielectric. Again, there is the error due to leakage, which is an important factor. In the case of the cable, moreover, the retardation of charge by the conductor resistance greatly influences the rate of absorption, so that the determination of its true capacity becomes a matter of considerable complexity and difficulty.

Speaking of the inexact results obtained by the ordinary Thomson and Gott methods, Mr. Young remarks, in connection with the latter test, that while Muirhead's correction is perfectly applicable for comparing condensers with one another, or with short lengths of cable, it is of little or no use for very long cables of, say, 1,000 or 2,000 nauts., apparently on account of the retardation of discharge by the conductor resistance.

The test recommended by Mr. Young as a more satisfactory method of measuring the exact I.C. than either the Thomson or Gott's method, both as regards correction for leakage and also the different rates of absorption of the condenser and cable, the peculiar manipulation of which was devised and first published by Mr. W. J. Murphy, is practically a combination of both these tests. As the principle of mixing the charges is employed, Mr. Young prefers to call it a *modified Thomson method*, though the connections are those for the Gott test, except that the galvanometer key is closed during the charge.

In this test both leakages and absorptions are balanced by

observation and adjustment during charging, absorption being treated as improvement in the D.R.

Inasmuch as the product of the condenser capacity (f) and its resistance (R) must equal the product of the cable capacity (F) and its D.R. (r), *i.e.*, $\frac{R}{r} = \frac{F}{f}$ —a condition suggested by "F. W." in the *Electrician* of February 5th, 1892—the slide contact must at starting be adjusted so that the two branches bear to each other the same ratio as F and f obtained approximately by a preliminary experiment.

The condensers are then shunted by a plumbago or other suitable resistance, which is adjusted until the galvanometer shows a balance with the *apparent* D.R. of the cable after any desired time of charge. During this part of the test the galvanometer key is closed. Having thus charged and balanced the *apparent* D.R.'s of f and F by observation, the latter part of the test is the same as for the Thomson test, *i.e.*, the charges in the cable and condenser are mixed, and the presence of any remanent charge in either of them detected by earthing the junction of the two capacities through the galvanometer. The exact means of carrying out this last operation is not shown in the diagram, but k_1 is evidently allowed to rise against an earth contact, thereby taking off the battery from the slides, and allowing the charges, f and F, to mix; after which, if k_2 be moved over to an earth contact, any discharge is shown on the galvanometer. That allowance can be made for the *cable current* by balancing to false zero is an essential feature, especially in a long cable. Though not stated, the false zero would obviously be observed, for the adjustment of the condenser resistance, with k_1 against an upper contact (not shown) either direct to earth or through a resistance equal to that of the battery, and with the galvanometer key k_2 closed; and the false zero for mixing, with k_1 also to earth and k_2 open.

The test has the advantage of requiring no specially constructed key, as used for the usual Thomson and Gott method, and it is an important point also that leakage on the battery does not affect results as in the ordinary Thomson test.

Mr. Young points out in connection with the Thomson test that for a ratio of 80,000 to 20,000 the effect of a leak of 10 megohms on the higher branch of the slides is to reduce the ratio to 3·9682 : 1 instead of 4 : 1, *i.e.*, nearly 1 per cent. error. This would only be the case were the leak wholly on the A side of the 80,000, whereas if equally distributed it would only be 0·2 per cent. The effect of the shunting powers of the resistances R and r upon the two branches of the slides, and the necessity for a correction if R and r are not in the same ratio as the slide readings, were also pointed out by Mr. Murphy. All the same, it is very important that the slides be well insulated, and so must also the galvanometer and key in the Gott connections.

It will be seen on referring to Mr. Young's examples of tests on Cable A in Table III. that not only are the results remarkably satisfactory by this *modified Thomson method*, but practically the same value is obtained for wide differences in the time of charge and D.R. values without having to *calculate* allowances for leakage. Uniform results are also secured by using as a basis the *constant* value of the balancing condensers obtained by comparison with standard air condensers by Muirhead's method and corrected for temperature. With regard to the coefficient for temperature variation applicable to the specific I.C. of gutta-percha core, this is said to be rather lower than the absorptive capacity of paraffin wax, viz., an increase of 0·025 per cent. for a reduction of 1° C.; but although this correction for G.P. would be desirable for a more exact comparison of the true I.C. of the cable, when laid at, say, 5° C., with the original factory value at 24° C., it does not necessarily enter into the question of correctly localising a very distant rupture, since the same mean result per naut. would be obtained for the full length laid as for the portion up to the break, provided that the mean temperature is the same, and both have been tested by the same method.

For comparison with the results by this modified Thomson method, Mr. Young gives examples in Table I. of tests on the same two cables by Gott's method, for which he calculates, by means of Siemens' formula for capacity by loss of charge, the error due to leakage on the cable and also on the condenser *separately*, and applies the *difference in the two errors* for correcting the measured result. This plan was suggested to him by Mr. W. J. Murphy, and gives also close results.

In Table II. there are also examples of tests by the ordinary Thomson method, corrected by calculation for the effect of leakage on the condenser and cable, which varies with their D.R. values, so that these results are also practically independent of the time of charge and agree very closely with the actual capacity of the cable.

For simplicity of execution and uniform results, Mr. Elton Young's modified Thomson method leaves little to be improved on.

Regarding a suitable time for observing the C.R., I.C. and D.R., the suggestion to adopt 30″ seems reasonable in the case of a laid cable. Economy of time, when repeated trials have to be made to secure a good balance, is important, and as electrification, or absorption, become very small after 30″ there appears no reason to exceed that interval. For a coiled cable it will be evident that 30″ would be out of the question, as retardation is very great and absorption proceeds at a very much slower rate. For a length of 300 or 400 nauts., two minutes is not excessive. What would be the minimum time admissible for mixing is a point which had best be arrived at by experiment. In fact, whether the principle of shunting the condensers is applicable at all in the case of a coiled cable seems very doubtful in view of the prolonged time required for mixing charges.

Dust Free Road-beds.—The use of oil in preventing dust appears to be an assured success. Oil has many advantages. By preventing dust it saves wear and tear of machinery, and diminishes the friction of boxes. It prevents the ruin of car draperies, which is now rapid in a dust-laden atmosphere. It destroys grass and weeds, and stops their reappearance. Then it forms a waterproof crust on the ballast, and prevents the percolation of rain. This keeps the road-bed dry, and arrests the decay of ties. It must also, in cold climates, much reduce the disturbing effects of frost, and save much labour in maintenance. In America the oiling of track is already advertised as a means of attracting passenger traffic. One application of oil will prevent dust for a year, the oil penetrating about 4 inches. A second and third application penetrates to below the ties. For absolute freedom from dust, a yearly application of about one-third the general supply is advisable. Road-bed oil is now specially manufactured by the Standard Oil Company. It has a high fire test and low gravity, and very little odour. Oil can be applied at a cost of about £6 to £9 per mile of single track, and the first or general treatment demands about 1,700 gallons per mile. American lines now use a special car for oil sprinkling, to which we beg to draw our English companies' attention, though it is certain that in England dust is as nothing compared with what is experienced in America and France. *Dixie*, to which journal we are indebted for our figures, shows train photographs before and after the oil treatment. Electrical tramways where laid off the public roads might copy the system.

INDISPENSABLE ACCESSORIES OF ELECTRIC TRACTION.

By HENRY E. P. COTTRELL, A.M.I.C.E.

(*Continued from page* 670.)

The following table gives the general dimensions, &c., of some of the trucks and cars used on the electric tramways in Great Britain and Ireland, on all of which the single truck principle of construction has been taken advantage of to the fullest extent :—

Table IV.—Some Examples of Peckham Trucks in England and Ireland.

Weight of car body with roof seats, 2 tons.

Where running	Bristol.	Bristol extension.	Dublin southern.	Dublin Clontarf.	Leeds.	Plymouth.	Dover.	Cork.	Coventry.
	Ft. Ins.	Ft. Ins.	Ft. Ins.	Ft. Ins.	Ft. Ins.	Ft. Ins.	Ft. Ins.	Ft. Ins.	Ft. Ins. and Ft. Ins.
Length of wheel base	5 6	5 6	6 0	6 0	6 0	5 6	5 6	6 0	6 6 and 5 6
" spring base	11 8	13 2	12 8	12 8	13 8	11 8	11 8	13 9	14 0 and 11 8
" top frame	13 2	14 9½	14 0	14 0	15 3½	13 2	13 2	15 3½	16 0 and 13 3
Gauge of rails	4 8½	4 8½	5 $2\frac{3}{16}$	5 $2\frac{3}{16}$	4 8½	3 6	3 6	3 0	3 6 and 3 6
Length of car body over doors	13 2	16 8	16 8	16 8	16 0	14 0	15 0	14 8	19 2 and 14 1½
" " " " dashboards	24 8	27 2	25 2	25 2	26 6	24 6	25 0	25 2	27 8½ and 22 7½
Capacity of car, number of persons	43	53	53	53	50	41	44	44	54 and 40
Weight of truck lbs.	4,690	4,448	4,658	4,522	4,690	4,690	4,690	4,450	5,112 and 4,782
Weight of motor car running empty tons	8	$8\frac{3}{4}$	$8\frac{3}{4}$	$8\frac{3}{4}$	$8\frac{1}{2}$	$8\frac{1}{4}$	8	8	9 and 8
Diameter of axles inches	$3\frac{3}{4}$	$3\frac{3}{4}$	$3\frac{3}{4}$	$3\frac{3}{4}$	$3\frac{3}{4}$	$3\frac{3}{4}$	$3\frac{3}{4}$	$3\frac{3}{4}$	$3\frac{3}{4}$ and $3\frac{3}{4}$
Weight of each axle lbs.	140	140	159	159	140	120	120	100	110 and 110
" " wheel, 30 ins. diameter lbs.	330	330	330	303	322	330	330	330	330 and 330

Class of Truck.—Bristol, Dublin Southern, Dublin Clontarf: standard cantilever extension 6 C. Bristol Extension; extra long 6 E Z. Cork: improved extra long 8 C. Coventry: extra long 6 E, and standard 6 C. Dover: standard cantilever extension. Leeds: extra strong No. 9. Plymouth: standard cantilever extension.—From Ph. Dawson's paper before the Society of Mechanical Engineers, November 3rd, 1897, on the "Mechanical Features of Electric Traction."

The maximum efficient support for the car body is secured with a minimum length of rigid wheel base by the combination of trusses which has been described. The details of the cantilever truck truss, however, merit careful description, as the excellent results it has afforded under working tests have undoubtedly been largely due thereto.

As constructed for oil. As constructed for grease.

Fig. 15.

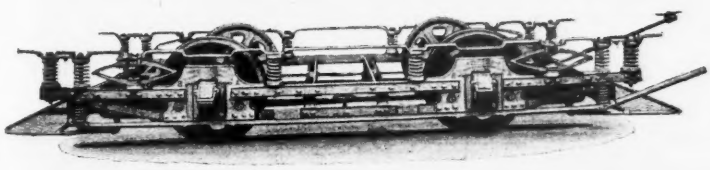


Fig. 16.

The side frames are composed of flat wrought-steel bars riveted to soft steel yokes or pedestals (fig. 15), which support the frames on the axle boxes, all the rivets being driven hot by pneumatic riveters. The lower member of the truss is coupled across the bottom of the yokes by distance pieces of soft cast-steel which are held in position by two bolts, fastened by lock nuts or with split pins through their ends, which are easily removable. Were these distance pieces omitted and the lower member of the truss partly or wholly incomplete, the trusses would be seriously weakened, the longitudinal stresses transmitted along them, especially when the cars are fully loaded, would tend to close the jaws of the yokes at their lower extremity and block the axle boxes, doing away with the play of the springs, and to permanently deform the truss between the two yokes by bending them upwards. The respective bearings of both these distance pieces and the yokes are accurately machine fitted, and the former have on their upper surface a cylindrical projection which forms a seat for the axle boxes when the cars are unloaded, the lower side of the axle boxes being provided with a cylindrical slot which fits loosely over this projection.

The axle or journal boxes can be constructed for use with either oil or grease, and are absolutely dust-tight. The covers and their seats are machine fitted and provided with leather packing, while their backs form a dust-tight stuffing box around the axle. To the underside of the frame work of the car floors the bar forming the top member of car under-truss is bolted. This is all in one piece between the extreme springs supporting the car body, but is made with depressions over each spring and bolt attachment, to facilitate getting at and removing any of them without having to jack up the car body. The car under-truss is completed by the ends of the raking extension rods being bolted to the same longitudinal joists of the floor frame, to which the bar previously mentioned is also bolted, the connection between the two being made by these joists, which thus form part of the under-truss. The angle of these extension rods or raking members of the truss, is not altered from the usual practice, the required longer support for the car being obtained by increasing the interval between the pedestals and the last coiled supporting springs to the extent demanded, the length of the raking portions remaining unchanged, while the coincidence of the under truss with the truck truss affords ample depth to the former and therefore ample strength of support to the car with the dimensions increased to the fullest possible extent. The car body is supported outside the pedestals, by double elliptic springs which are sufficiently stiff to support the car body when light, and sufficiently flexible to ensure easy running under light loads while the spiral springs do not act.

When the car is loaded the elliptic springs are compressed and lose elasticity owing to the increased leverage in the flattened spring, and the four wide spiral springs take the weight and maintain easy running. In addition to these side coiled springs (fig. 15) double coiled springs are inserted just inside the extreme side coils which act as a dashpot taking up the pitching motion of the car body whatever its cause, and rapidly stopping and doing away with all bumping. Emergency overloading of the car whereby the "top bar" or sill of the car body is brought in contact with the top of the pedestals is provided for, by the fixing of rubber cushion springs thereon.

The framework of the truck trusses does not rest directly on the axle or journal boxes, but is supported by a double set of spiral springs (one inside the other) which take up and do away with the first shock caused by a rough track. These springs are right and left handed, to counteract the torsional strains set up in the springs themselves by shortening. The outside spring takes up and deals with the light shocks, the second or inside spring with heavy shocks, both being so designed and proportioned that the respective loads for which they are designed produce the same strains and relative compression in each, and when the maximum loads are reached, the successive coils come in contact at the same instant.

Referring to figs. 11 and 12, it will be seen that in these truck trusses, the framework is supported by two separate coiled springs resting on prolongations of the axle boxes below the journals. These springs have to take up both light and heavy shocks, and are not graduated so as to differentiate between the two and present stiffer coils to the latter than to the former. This arrangement is neither so scientific nor so practical as the one previously described.

The motors hang from crossbars suspended from side frames by coiled springs, and are provided with a set of springs to take up the jerks caused by shocks and to prevent oscillation.

Till electric traction was introduced, rubber was universally used for street car springs. The rubber springs were then replaced by coiled springs with rubber cores, the latter

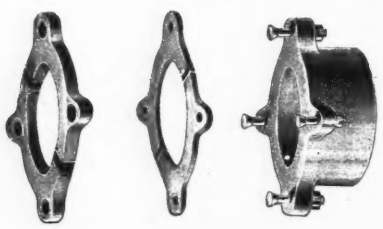


Fig. 17.

adding a graduated action to the former. The coiled springs were wound in conical and barrel shapes, the coils of larger diameter acting under light loads and those of smaller diameter under heavier loads, thus ensuring a graduated action in the spring itself. Finally, the type of an outer and an inner spring coiled in opposite directions was evolved with the best results.

The use of elliptical and spiral springs in combination has now become universal, the former being more sensitive but also more confined in range, are more suitable for light loads, and the latter for heavy loads, but the former possessing more lateral stiffness are also more suitable for counteracting rolling motion.

The universal practice in tempering is to dip the springs at a cherry heat for a short time in oil and then to cool them gradually.

The use of springs is by no means confined to producing the easy riding so much appreciated by passengers, an even more important function being the protection of the car body, of the motors, and of the truck itself from the effect of sudden concussions and jolts. The difference in the running of the improved American electric car and the old horse car is even greater than the difference between the running of an old suburban railway carriage and a Pullman car.

The next point to be considered is the axles. The increase in the diameter of axles since electric traction has been introduced, as compared with the dimensions in use for the axles of horse cars, is remarkable, as the subjoined table will show :—

Table V.—Comparison of Axles on Horse and Electric Cars.

Style o car.	Diameter of axle between wheels.	Diameter of axles in hubs of wheels.	Journals.		Total weight of car empty.	Depth of key-way in axle.	Seating capacity.
			Diameter.	Length.			
	Inches.	Inches.	Inches.		Lbs.	Inch.	
Four-wheel electric motor car ...	3⅜ to 3⅞	3 to 3¼	2⅞ to 3½	6 to 6½	11,000 to 13,000	½ to ⅝	30 to 50
Four-wheeled two-horse car ...	2½	2½	1⅞	4¾	5,000 to 6,000	...	30 to 46

In both electric cars given above the gauge is 4 feet 8½ inches, and 30-inch wheels are used.—From "Electric Railways and Tramways," by Ph. Dawson, C.E.

The reason for the above increase is not far to seek, the difference in loads and the liability to concussions is relatively greater on electric tramways than on an ordinary railway owing to the much wider differences in the numbers carried, and to the more serious inequalities presented by the track of a tramway as compared with that of a railway, so that the factor of safety in the first must be at least as great as in the second, since the speeds are fairly comparable, which is not the case as between horse tramways and ordinary railways. In electric trams the inequality of loading may reach as much as 45 per cent. of the total load, and the difference in level between the ends of rails very often exceeds ¼th of an inch, neither of which circumstances are conceivable on a railway.

Fig. 18.

The metal of which the axles are composed tends to acquire a crystalline texture under the influence of the torsional strains set up by the repeated stops and starts of a tramline. It, therefore, becomes brittle and liable to fracture quicker than is the case on an ordinary railway where the stops and starts are nothing like so frequent. A large factor of safety and cushioning to protect the axles from the effects of sudden shocks is evidently absolutely necessary, hence the tendency to ever increase the diameter of the axles in use, and be more and more particular about the distribution of the springs.

The best axles are now made of rolled steel containing from 16 to 17 per cent. carbon, they are cheaper than forged axles and give the best working results. These axles are not turned down on the lathe, but are die drawn, their torsional and transverse strength is thus increased in a similar fashion to that of wire. The hubs of the wheels are formed of malleable iron and pressed on the axles under hydraulic pressure of 35 tons to the inch (figs. 17 and 18), and in a similar way the steel collars for the motor axles are pressed on under hydraulic pressure of 10 tons. This avoids all necessity for weakening by cutting grooves in the axles, as well as the possibility of loose wheels or loose collars. Such keyways as are necessary for motors are cylindrical in shape, like the collars themselves, more angular or resisting forms being found to be unnecessary.

The wheels are constructed of best chilled car-wheel iron

and turned up to steel templates, so that all wheels are interchangeable and can be used on any hub. They can be secured to the flange of the hub by seven $\frac{7}{8}$ inch bolts provided with positive lock nuts (figs. 19 and 20). An elastic tubular tapered cushion of the best quality of rubber

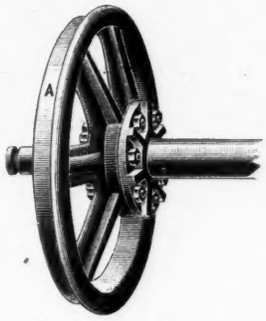


Fig. 19.

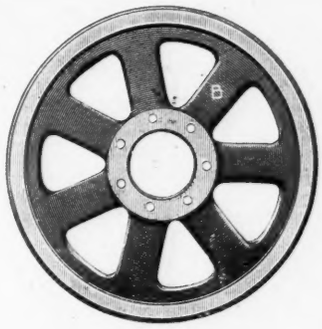


Fig. 20.

with a working life of over three years, is inserted between the hub and web, exactly filling the space between them. This sustains the entire weight of axle (sufficient allowance being made in the bolt holes to relieve the bolts). This cushions the axle, motor and wheel, thereby retarding crystallisation and fractures resulting therefrom.

The following table extracted from the books of the New York Car Wheel Works, who supplied the Consolidated Traction Company with wheels for the year 1897, gives the percentage of repairs of wheels in four well-known types of truck :—

Table VI.

	No. of trucks in use.	No. of wheels in use.	No. of wheels repaired.	Per cent. of total.
1. McGuire ...	20	80	69	86
2. Bemis ...	17	68	49	72
3 Brill ...	342	1 368	993	72
4 Peckham ...	210	840	341	40

The above shows the effect of difference in construction upon wear and tear, and consequent maintenance.

The brasses in the journal boxes have their sides and ends rounded off to permit good lubrication and avoid wearing collars on the axles. Those in the best types of truck last from 6 to 8 years ; the ordinary brasses are, however, often replaced by various forms of roller bearings which are stated to effect a sensible economy in the motive power required for propelling the cars. The journal boxes provide $\frac{1}{4}$-inch space for end play in the axle, and can be run without overhauling for some 8 to 12 months.

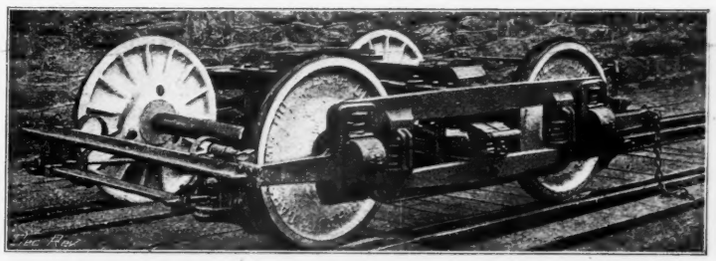


Fig 21.

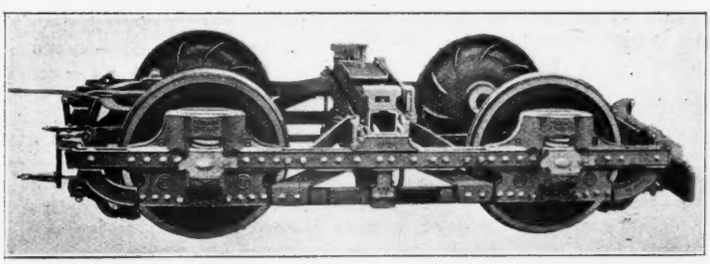


Fig. 22.

The second form, or the articulated or radial truck, is so little used that it is not worth while discussing, but the various forms of the swivel or bogie truck are daily becoming of more importance in electric traction work, and therefore require careful consideration as they have to meet the most varied conditions of speed, and their designs have to be varied accordingly.

Just as the bogie truck has gradually supplanted the pedestral underframing on the rolling stock used for main lines on railways, so have special forms of this same truck replaced the four-wheel extension truck for interurban electric tramlines or light railways. The conditions demanded for an ideal bogie truck are the following :—

1. The car body must be free to swivel round its points of support with minimum friction, *i.e*, the area of the swivelling plates must be as small as possible and the surfaces in contact must be protected from dust and self-lubricating.
2. The centre of gravity of the trucks must be brought down as low as possible.
3. The rigid wheel base must be kept as short as possible.
4. The load must be so supported by the truck that it cannot move longitudinally independent of the truck, nor sensibly increase the proportion carried by the outer journals in rounding curves.
5. The springs and bolster attachments must be so arranged as to be readily got at to remove them, or the truck, from under the car, without jacking up.
6. The brakes must be automatically adjustable, so that their action on the wheels shall be constant.
7. The trucks must be as free as possible from liability to tilt under the action of the brakes.

Figs. 21 and 22 represent two forms of trucks designed for extra heavy high speed service, one known as the Brill perfect truck No. 27, the other as Peckham extra strong 14A. The same relative superiority in the disposition of the metal employed in the framing in fig. 22, as compared with fig. 21, which was pointed out in the single truss cars previously discussed, exists here.

The first desideratum can be equally attained in both forms, but the disposition of weight so as to lower the centre of gravity is obviously in favour of No. 22, while the support given to the brake rigging is also more efficient than that afforded by fig. 21.

(*To be continued.*)

D

THE ELECTRIC CURRENT IN CHEMISTRY.

(*Concluded from page* 671.)

However, it is not alone in the field of pure chemistry that helpful and interesting consequences of the introduction of the "subtile agent" are found. The patient, careful analyst, as he struggles to unravel the problems Nature has placed before him, will ever hold sacred the name and memory of Dr. Gibbs, who, in 1865, first called the attention of the chemical world to that simple yet beautiful and extremely satisfactory determination of copper in the electrolytic way which proved the incentive to further study in this direction, so that at present 21 metals lend themselves to electrolytic determinations from solutions of the most varied character, and in the same manner at least 120 separations have been made, all of which for accuracy, neatness and rapidity leave little to be desired.

In the commercial manufacture of potassium chlorate, potassium persulphate, caustic, alkali, iodoform, &c., &c., those who seek to apply the principles of chemistry in the establishment of industries of national import have found in the electric current a most fruitful aid, the full consequences of which are yet untold.

The foregoing is a condensation of a portion of the address given by Prof. Edgar F. Smith, of the American Association for the Advancement of Science, before the chemical section of this society last autumn. The remainder of his address is of such a nature that it is almost impossible to make any abstract, for the matter is itself so extremely condensed. The lecturer having given a sketch of the leading features of electro-chemistry, proceeded to call the attention of his hearers to the researches which have been made in what we may term, perhaps, electro-organic chemistry. He started with those classic experiments made about 50 years ago by Kolbe on the electrolysis of concentrated solutions of potassium, acetate and valerate; and then took his hearers through the researches successfully carried out by Kekule in 1864 on the electrolysis of the dibasic acids. Next, he reviewed Brester's work in 1866 on various aliphatic bodies, and then passed to Aarland's work on citraconic acid and its isomerides, in connection with which Carstanjen's valuable suggestions received due notice. Continuing his review of the relation between electricity and organic chemistry, Prof. Smith did not omit Bourgoin's work on the electrolysis of the succinates. And then he gave pause in order to sum up Kolbe's opinion regarding how these organic decompositions took place. Taking acetic acid as an example, Kolbe represents his idea as follows:—"The acetic acid in the field of the galvanic action is oxidised by the oxygen, so that it is resolved into carbon dioxide and methyl, both of which appear at the positive pole, while only hydrogen is formed at the negative electrode."

Kolbe, Kekule and others regarded the decomposition of the organic acid as a secondary reaction. The oxygen arising in the water decomposition they considered exerted an oxidising effect upon the acid. Bourgoin's researches upon the electrolysis of organic acids were very extensive, and it was the opinion of this investigator that the most important phase in their electrolysis was the production of intermediate anhydrides of the acids. These, Bourgoin thought, then parted with oxygen, and secondary products were formed. In this latter class he included the passage of the anhydride into the acid by water absorption, as well as the oxidation of the acids by the oxygen released from the acid.

But we ask: Are an anhydride and oxygen formed before the hydrocarbon is produced? If so, does the oxygen then decompose the anhydride with the formation of the hydrocarbon and carbon dioxide? We are not alone in this inquiry, Löb has endeavoured to find an answer in the experimental way. To do this, he electrolysed phthalic acid, dissolved in alcohol (a little sulphuric acid was added to increase the conductivity), with a feeble current. The latter was allowed to act for several hours, and there resulted an almost quantitative yield of phthalic anhydride. It is not surprising that this chemist inclines to the view of an intermediate anhydride formation, but he wisely says that this is only demonstrable with acids, whose anhydrides are very stable,

In dealing with the electrolysis of free acids we can scarcely assert that breaking down occurs, because the acid reappears as such at the positive electrode. Graphically represented we should have:

1. $2\,CH_3\,.\,COOH = 2\,CH_3\,.\,COO + H_2$
   $2\,CH_3\,.\,COO + H_2O = 2\,CH_3\,.\,COOH + O.$

or $2\,CH_3\,.\,COOH = 2\,CH_3\,.\,COO + H_2.$
$2\,CH_3\,.\,COO = (CH_3\,.\,CO)_2\,.\,O + O$
$(CH_3\,.\,CO)_2\,O + H_2O = 2\,CH_3\,.\,COOH.$

The first equation shows that oxygen comes from the water, while in the second it has its origin in the intermediate anhydride formation.

But let us follow Löb, and with him substitute hydrogen sulphide for water, then the equations just written would appear thus:

$$2\,CH_3\,.\,COOH = 2\,CH_3\,.\,COO + H_2$$
$$2\,CH_3\,.\,COO + H_2S = 2\,CH_3\,.\,COOH + S.$$

or $2\,CH_3\,.\,COOH = 2\,CH_3\,.\,COO + H_2$
$2\,CH_3\,.\,COO = (CH_3\,.\,CO)_2\,O + O.$

$$\left.\begin{matrix}CH_3\,.\,CO\\CH_3\,.\,CO\end{matrix}\right\rangle O + H_2S = CH_3\,.\,COOH + CH_3\,.\,COSH.$$

What do these teach us?

1. If an intermediate anhydride is not formed, then the original acid will be regenerated and sulphur will separate.

2. If the anhydride is produced, an evolution of oxygen will take place, and a molecule of a thio-acid will be obtained for every molecule of the ordinary acid.

An experiment was performed to test these ideas. Very pure acetic acid was reduced to a low temperature, and in this condition saturated with hydrogen sulphide. It was electrolysed, the gas being still conducted into the solution. Not a particle of sulphur separated at the anode, and the solution contained thio-acetic acid.

Two experiments, therefore, indicated the formation of an intermediate anhydride. However, other views are prevalent. Thus, Schall entertains the opinion that a peroxide is first produced in the electrolytic decompositions of the class we are considering. He electrolysed the alkali salts of dithio-acids and obtained persulphides of the acids:

$$2\,CH_3\,.\,CSS - = \begin{matrix}CH_3\,.\,CSS,\\CH_3\,.\,CSS\end{matrix}$$

and then the action ceased. It may be because the persulphides are so much more stable than the corresponding peroxides. Schall apparently has been confirmed and, indeed, antedated in his views, for Bunge, in 1870, subjected thio-acetic acid and thio-benzoic acid to electrolysis and obtained acetyl disulphide and benzone disulphide, "facts which," the author remarks, "justify the conclusion that the compound group separating in the electrolysis of the thio-acids, at the anode, is liberated as a complex."

Hamonet conducted an extensive series of experiments with the alkali salts of the fatty acids. Inasmuch as he worked upon a much larger scale than his predecessors, his conclusions are entitled to thoughtful consideration. They are in substance:—

1. The equation expressing the decomposition of salts of the fatty acids as introduced by Kolbe cannot be regarded as correct. Frequently, paraffin hydrocarbons are not obtained, or at least in very small amounts.

2. The olefines predominate in this decomposition.

3. An alcohol with n — alcohol atoms is invariably formed if the acid contains $n + 1$ — carbon, and its structure is not always what we might expect.

So much for the acids. Plainly this particular line of inquiry needs and deserves further attention from the investigator.

The changes induced in organic substances by the electric current are, as a rule, so complex that their study is surrounded by vastly more and greater difficulties than obtain in the electrolysis of inorganic bodies. V. Miller, recognising this feature, has adopted means of continuously exposing and withdrawing electrolysed products from the field of action. In this manner he has striven to obtain a more complete picture of what actually occurs under the influence of the current.

Brown and Walker, keeping in view the fact that Kolbe had synthesised hydrocarbons by electrolysing fatty acids

and the additional knowledge that ester groups are electrolytically inactive (first observed by Guthrie), effected some most interesting electro-syntheses. They were not entirely successful with the ester salts of unsaturated dicarboxylic acids, in which an ethylene union is present.

We must not omit mention of a rather interesting result, recently communicated by v. Miller and Hofer. As observed, these chemists have entered quite largely into the study of the electrolysis of what may be termed mixtures. They obtained results which are the first examples of electro-syntheses being used to determine constitution which could not be arrived at in any other way.

Mulliken has also brought to light a new class of electro-syntheses. He has directed his investigations mainly to bodies containing a $-CH_2-$ or $-CH-$ group, in union with more negative groups. We know that such substances contain hydrogen, which can be replaced by metals. Their sodium salts in alcoholic solution conduct themselves like electrolytes; they break down into sodium and a complex anion—the carbonaceous residue. The products obtained in all the electro-syntheses thus far made are the same one would expect to be formed by the action of iodine on the sodium or silver compounds of the substances electrolysed.

Weems has continued this line of investigation, and from his results has felt justified in concluding that the electro-syntheses effected from malonic ester, methin-tricarboxylic ester, acetylacetone, and aceto-acetic ester are best explained as the result of the direct union of the anions. "Pairing of anions has been shown to be of particularly common occurrence in the electrolysis of sodium compounds of derivatives of malonic ether." Such pairing has been observed in certain examples of the aceto-acetic ester type, but it can scarcely be said to be general. Pairing of anions does not take place in the electrolysis of compounds like acetamide, benzamide, succinimide, and phthalimide. The same holds with their sodium and mercury salts.

Prof. Smith then reviewed the deportment of the alcohols when exposed to the electric current, and then passed to the aromatic series and considered critically the views which had been put forward regarding the decompositions which follow by Gattermann and Elbs. He then passed on to the theory which Löb has recently proposed in order to explain the reduction of the three nitrobenzoic acids, touching upon the views which have been expressed by Noyes, Dorrance, Clements, Ahrens, and other well-known workers in this fruitful field of research.

Naturally, Prof. Smith could only deal in a very sketchy way with the voluminous researches in organic chemistry which the application of electrolysis has produced. These are, as he said, highly suggestive, and it is difficult to foreshadow what they will lead to. Indeed, we are reminded of those words which Michael Faraday used years ago, who we may look upon as one of the fathers of electro-chemistry, words with which we suitably conclude this paper, viz. :—

"It is the great beauty of our science .... that advancement in it, whether in degree great or small, instead of exhausting the subjects of research, opens the doors to future and more abundant knowledge, overflowing with beauty and utility, to those who will be at the .... pains of undertaking its experimental investigation."

SULLIVAN'S UNIVERSAL SHUNT.

For use with his well-known galvanometer Mr. Sullivan has designed a special universal shunt of the Ayrton-Mather form, in which he applies the principle of the Thomson-Varley slide resistances, with the result that a very fine degree of sub-division is obtained.

The ordinary universal shunt gives only a limited number of ratios, while each of the 101 coils of 1,000$^\omega$ each in the Thomson-Varley slide is only sub-divisible into 100 equal parts.

In the Sullivan shunt only 11 (instead of 101) coils of 1,000$^\omega$ each are employed and the sub-division is carried down to one ohm, a very wide range of ratios or multiplying powers being consequently attained.

Fig. 1 shows the theoretical connections of this shunt box, and fig. 2 the box as arranged in practice.

The actual connections are made by means of sliding contacts over the studs of the above four sets of coils, No. 1 set of which contains 11 coils of 1,000$^\omega$ each, No. 2 11 coils of 200$^\omega$, No. 3 11 coils of 40$^\omega$, and No. 4 10 coils of 8$^\omega$ each.

Two sliding contact springs insulated from each other ride over and embrace two coils of Nos. 1, 2 and 3 sets, and each

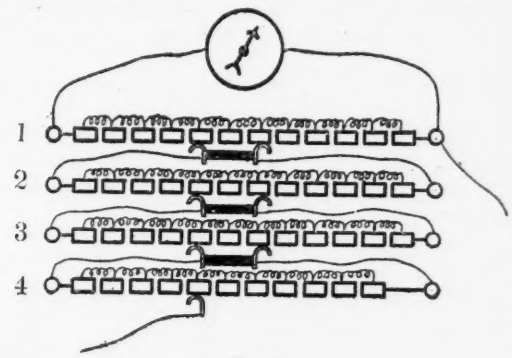


Fig. 1.

pair of coils so embraced is permanently in parallel with all the coils in the next lower set. No. 4 sliding contact is a single one. Thus we have derived circuit upon derived circuit, the function and the action being similar to that of a Vernier on a scale, only that the sub-division is carried further, as each 1,000$^\omega$ coil can be sub-divided by means of the second set of coils into 10 equal parts; by means of the third set of coils, into 100 equal parts, and finally by means of the fourth set of coils into 1,000 equal parts.

It will thus be seen that this shunt reads differences of one ohm and allows of the flow of current through the galvanometer being regulated with the greatest degree of nicety in practice. To ascertain the ratio or multiplying power of any

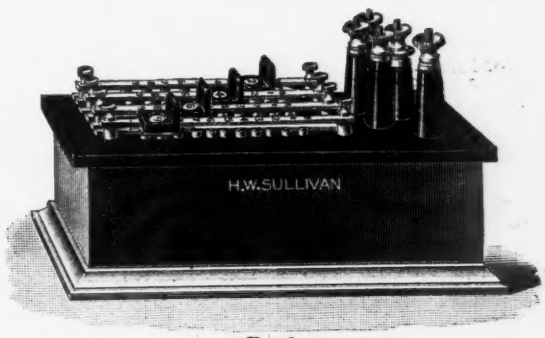


Fig. 2.

shunt reading it is simply necessary to draw its reciprocal number, the shunt readings being of course treated as decimals. For example, a shunt reading of 4,554 would be ·4554, the reciprocal number of which is 2·19587.

Or the ratio of the reading to 10,000

$$\frac{10,000}{4,554} = 2{\cdot}19587$$

This shunt box can also be very conveniently used as a proportional bridge in resistance measurements or to serve as the resistances in Thomson's inductive capacity test.

It should be mentioned that in addition, the box contains an independent coil of 100,000$^\omega$ which forms a very convenient standard for the comparison of high resistances by the direct deflection method, or for localising faults in cables by the fall of potential test.

Society of Arts.—On Wednesday evening Mr. W. H. Preece, C.B., F.R.S., read a paper on "Ætheric Telegraphy."

THE INSTITUTION OF ELECTRICAL ENGINEERS.

At the meeting when Messrs. Duddell and Marchant's paper on "Investigations of Alternating Arcs by Means of Oscillographs" was demonstrated by the authors, Mr. L. Andrews described some similar experiments he had made, which were criticised by Prof. Ayrton.

The discussion on Messrs. Duddell and Marchant's paper was resumed on Thursday, the 27th ult., by some further remarks from Mr. Leonard Andrews, who replied to Prof. Ayrton's inquiries whether he had taken steps to ascertain the accuracy of the method used. Mr. Andrews admitted that his method was by no means as accurate as that employed by Messrs. Duddell and Marchant, but it had rather a different object in view. He was anxious to find out something about the things that occur when an incident happens in a central station which was liable to disarrange and affect the supply. Take the Brighton breakdown, for instance, several theories have been suggested, but no one seems to know quite what did happen.

Some years ago Mr. Raworth suggested to the speaker that it might be possible to photograph the current and pressure curves, and he had applied the suggestion to the elucidation of the effects of suddenly opening the field circuit of an alternator running in parallel with others on a pair of bus bars. Reproductions of the curves obtained—stretching for yards along the walls of the hall—showed that the telephone diaphragm method could be relied upon to give information as to the displacement in phase of one current behind another. The exciting current was suddenly reduced by a resistance being switched in so as to halve its magnitude, and the history of the effects was given on the curve up to the time when the automatic switch cut the machine out, the whole taking less than one second to effect.

Several suggestions were made by speakers later in the discussion as to the uses for the oscillograph in telegraphic and telephonic work. Mr. Duddell retorted in his reply that the apparatus might be used individually by those desirous of investigating such fields.

When Mr. Mordey was called upon to speak, he said that when he moved the adjournment of the discussion it was rather from fulness of his heart than fulness of his head. He had never seen such a beautiful demonstration in his life. One was able now to realise things that take place in practical work. The apparatus employed surpassed—well, anything you like, and the painstaking work deserved the thanks of all electrical engineers. After a few further words of congratulation by Mr. Mordey, Dr. Fleming expressed his feelings that there was no need to add to the chorus of praise, but proceeded to do so by comparing the old point-by-point methods with the oscillograph; the former had been discarded by him in some projected experiments on alternating arcs, because life was not long enough to get the data required. The new method would do more in an hour than the old would compass in a week, and the clumsy point-by-point method was quite out of the question where the curves flickered about as it were.

The most interesting thing to him was the behaviour of arcs between a metal and carbon; the current only flowed when the metal was positive, and the arc possessed unilateral conductivity. In 1890 he had showed experiments illustrating the flow through vacuous space of current between a metal plate and the carbon filament in an incandescent lamp. He also referred to Wurtz's experiments on the non-arcing metals, and reminded the meeting that those which could not maintain an arc were, in chemical language, the monatomic metals. On the subject of alternating arcs he referred to a paper of four years ago, in which it was stated that the luminous efficiency was increased by lowering the frequency, and explained that this might be attributed to the distinct lag between the light curve of an alternating arc and the current.

Dr. S. P. Thompson expressed his most profound admiration of the paper, and congratulated Prof. Ayrton and the Central Technical College that such excellent work had been brought before the Institution. The appliances were an instrumental triumph. A number of interesting problems had been raised. It had long been known that the current in the arc did not keep step with the voltage, yet there was neither lag nor lead, but the curves showed that the peaks were of more importance than the points where the current and pressure curves crossed the zero line. He had endeavoured to predict the curves from Mrs. Ayrton's data, and gave some particulars to show that he had succeeded in showing an agreement between her paper and the one under discussion.

Prof. Ayrton called Blondel the Father of the Oscillograph, but Blondel had dropped that instrument only to take it up again. When the writers had shown what it was capable of doing, Blondel returned to the instrument, and a recent paper before the Physical Society of France dealt with oscillographs, while two papers had been presented to the French Academy in December, 1898, and in March this year on the same subjects. He pointed out that Mrs. Ayrton's data could not be used as Dr. Thompson had attempted, because her investigations only gave results for "normal" arcs, and an alternating current arc could not give such results, the shape of the carbons being quite different.

Mr. Campbell Swinton wanted to know the limit of frequency for which the oscillograph was available, as many of the actions in the Wehnelt contact breaker were obscure, and some light might be thrown upon them by its aid. Another speaker dealt with the lag of light behind the power curve and showed how extremely rapidly the radiation followed the power.

Mr. Duddell, in replying to the discussion, said his apparatus would shortly be put on the market by the Cambridge Scientific Instrument Company. He referred to Blondel's experiments, and quoted a suggestion of that physicist, that the experimental arc should be put in the working lantern when the blank part of the curve on the screen would show the extinction part of the light curve. With respect to the frequency for which his apparatus was useful, it could easily be used up to 500 periods per second, and in greater refinement of construction much higher even than this.

Mr. Murphy then explained the method of measuring capacity described in Mr. Elton Young's paper. Mr. Siemens having spoken thereon, the discussion was adjourned until next meeting, on May 4th, when a paper by Mr. P. V. McMahon on "Electric Locomotives" will be read.

TELEGRAPH RATES TO INDIA.

The *Times* of last Saturday writes as follows on this subject, and fully bears out the views which we expressed in our last issue:—

"In the Indian Budget debate, Lord Curzon described the tariff for telegrams to Europe 'as inimical to trade, a barrier to the ever-growing intercourse between India and the mother country, and obsolete and anomalous in itself.' Strong facts would be required to justify such words from a Viceroy. The evidence which has reached England by this mail affords a justification for them ample in degree, and somewhat startling in kind. It tends to show that not only is the charge in excess of the reasonable price of the service rendered to the Indian public, but that it is out of all proportion greater than the corresponding service rendered through India to Australia, and has proved prohibitive of the extended telegraphic communication which is a necessity of Indo-European trade.

"The Madras Chamber of Commerce, in a letter to the Government of India, thus summarises the facts. It states the charge for telegraphing between England and India at 4s. a word, and the charge for double the distance between England and South Australia, *viâ* India, at 4s. 9d. a word. That is to say, a telegram is charged 4s. a word for the first or lesser half of the distance—*i.e.*, to India—and only 9d. for the second or greater half of the distance on from India to Australia. This general statement is, we believe, subject to certain modifications according to the route and the destination of the telegram in Australia. But it fairly represents the facts, and it certainly justifies Lord Curzon's application of the term 'anomalous' to the existing tariff. The effect of that tariff on the use of the telegraph is full of instruction. In 1891, says the *Madras Mail*, the charge per word from Australia to the United Kingdom was reduced from 9s. 4d. to 4s., or less than one-half, although afterwards slightly raised to, say, 4s. 9d. During the next seven years an enormous development took place in the 'trans-Indian' telegrams, by which is meant the messages from the United Kingdom through India to Australasia. The number of transmitted words, which amounted to under 2½ millions in 1891-92, rose to just under four millions in 1897-98. The disproportionate Indian charge for half the distance precluded, on the other hand, any material development in telegraphic communication between India and England. The number of words has during the same seven years remained almost stationary at under 2½ millions in 1891-92 and just over 2½ millions in 1897-98.

"If the figures as given by the Madras Chamber of Commerce and accepted by the Indian Press be correct, this seems to be a clear case of the natural course of development being arrested by excessive charges. While the general use of the telegraph in India increased from 3⅔ million paid messages in 1891-92 to 5 million in 1896-97, the number of words from India to the United Kingdom has almost stood still. The explanation is, as the Madras Chamber of Commerce points out, that the high rate between India and England compelled Indian merchants to resort to code messages to an extent inconvenient and often unsatisfactory to themselves. 'The condensation of messages' under the pressure of an excessive tariff has been carried to such perfection by banks and mercantile firms in India that, unless under the impulse of some special and usually fleeting activity in trade, 'no great expansion of traffic is likely to ensue.' In short, the Indian mercantile community has fought by its telegraph codes the high rates to England against which it protests in vain.

"A disheartening feature of the case, and one which justified the plain speaking of the Viceroy, is that all this has been long realised, and that the efforts made to find an escape from the situation have proved fruitless. The present rate, which has been practically in force 'for the past 15 years or more,' was perceived to be 'obsolete' as clearly by Lord Lansdowne and Lord Elgin as by Lord Curzon. In 1893 the Government of India declared that 'the reduction of the tariff to India is a measure of Imperial importance.' In 1896 it instructed its delegates to the International Telegraph Conference at Buda-Pesth to urge a reduction, and in 1897 it expressed its 'great regret that some reduction had not been secured.' At that Conference, as at many another, the advocates of progress found vested interests too strong for them. They reported that their efforts had failed, because the Eastern Company declared that it could not consent to any abatement unless the Government of India would guarantee it against possible loss. The Secretary of State had already intimated that he was not prepared to press such a guarantee on the Indian Government, and, in spite of a running fire of protests from the Indian public ever since, the grievance remains unredressed.

"This is the situation with which Lord Curzon has now to deal. One section of his advisers among the mercantile community would deal with it in an off-hand fashion. They insist that the opposition to the Eastern Company at the Buda-Pesth conference was not justified by the financial facts. They pointed out that for the nine years ended 1897 it paid the high dividend of 6½ per cent, and raised it to 7 per cent. for 1897-8; and that it has accumulated a reserve fund which, with the credits at certain special funds, considerably exceeds one million sterling, while its ordinary stock stands at 75 per cent. premium. They hold that such prosperity should not be purchased at the cost of the public, and that such an inflation of capital should not be maintained by an excessive tariff. We are not concerned to examine the figures too closely. For we do not believe that the general course thus indicated will commend itself to fair-minded men. The companies took certain risks under certain conditions sanctioned by the Indian Government. If their venture has turned out successful and they are now reaping the fruits, they are to be congratulated, or even envied, but not to be plundered. Yet a telegraph company, like a railway company, does well to remember that sooner or later it must reckon with public opinion, and that its safe policy is not to allow adverse opinion to gain too strong a head against it.

"A more hopeful line of approach may be found by re-opening the question of a guarantee to share the loss. When the tariff to Australia was cut down to one-half in 1891, the Colonial Governments gave a guarantee of this kind. During the first year of the new scale the loss amounted to £55,000, diminishing to £12,000 in the third year, and disappearing altogether, we understand, in the fourth year. Since then the loss has been turned into a profit from the impulse given to the use of telegraphic communication by the low rate; and the Colonial Governments and the companies alike benefit from their courageous action. The Indian mercantile experts believe that a similar reduction in tariff would lead to similar results. It is unsafe to speak confidently on the subject, but they produce reasons for a good hope. The reduction, to be effective, must be a substantial one. If, during the past seven years, the total net value of the Australian telegrams *via* India rose from £284,427 to £512,017, while the value of messages between India and the West practically stood still, the result was attained, not by any timid curtailment of 6d. or 1s. a word, but by a bold reduction of 50 per cent. The Madras Chamber of Commerce urges an equally vigorous course on the Indian Government, and maintains that telegrams between Great Britain and India could be carried at a profit for 2s. instead of 4s. a word. The subject is complicated by the question of capacity of the existing lines for so great an increase of traffic. But to such difficulties an easy solution is offered by low-interest loans for new constructions, or, if needful, for a new cable, under a Government guarantee, at 3 or 3½ per cent. The main question is whether Lord Curzon, when he has had time to consider the case in all its bearings, will think himself justified in dealing with it in the resolute spirit and with the trust in the future which the Australian Governments displayed nine years ago. Possibly, however, the construction of the Pacific cable, which now seems assured, and the new competition it will create for Australian traffic, will induce the Eastern Company to reconsider its policy of unprogressive resistance and avert the necessity for more drastic remedies."

Leatherhead.—The Urban Council has placed a three years' public lighting contract with the gas company (incandescent burners), and on the question of electric lighting will obtain the opinion of the ratepayers by sending round circulars.

LEGAL.

National Company for the Distribution of Electricity by Secondary Generators *v.* Gibbs.

In the Chancery Division of the High Court of Justice, before Mr. Justice Cozens-Hardy, on Friday, April 28th, this case came on for judgment on a point raised in the course of the hearing on the 17th and 18th ult. in an action brought by the plaintiffs for specific performance of two agreements of May 25th and October 31st, 1883.

Mr. Justice Cozens-Hardy said the plaintiffs in the action contracted on May 25th, 1883, to purchase certain letters patent for a large sum of money. The vendors were Gaulard, who died in 1888, and the defendant, Gibbs, Gaulard's administratrix, Madame Ruelle, was a defendant to the action. It was admitted that the plaintiffs had settled their dispute with Gibbs, and it was, therefore, unnecessary for him to consider the action except as one between the plaintiffs, who were the purchasers, and the defendant, Ruelle, who was the administratrix of Gaulard, one of the vendors. The plaintiffs claimed that the defendant might be ordered to assign to the plaintiffs the letters patent, and they also claimed damages for breach of the agreement and warranty contained in the contract of May 25th, 1883. At an early stage it became apparent that there was a serious question whether the plaintiffs had any right against the defendant, Ruelle, and with the approval of the parties, his Lordship thought it was convenient to deal with this point separately, because if it was decided adversely to the plaintiffs, it would not be necessary to consider other questions of foreign law which might arise. The short point was whether Gibbs, the surviving patentee, was not the only person having anything to assign, and the only person liable to pay damages for breach of contract and warranty. It was admitted that all the patents were granted to Gaulard and Gibbs, and not to either of them separately, and it was not alleged that their rights, *inter se*—whatever they might have been originally—had since been varied, except so far, if at all, as they were varied by the contract. The first question to be answered was as to the nature of the interest of the patentees. The patent, dated September 13th, 1882, which was the only one to which his attention had been called, was in the usual and universal form in the case of a grant to two patentees. It recited that Gaulard and Gibbs had presented their petition, and that they were the first and true inventors, and that they had prayed her Majesty to grant unto them, their executors, administrators and assigns her Royal letters patents for the sole use, benefit and advantage of the said invention within the United Kingdom for the term of 14 years. On the construction of this grant his Lordship thought that the two patentees took a joint interest which passed by survivorship to Gibbs on the death of Gaulard. In his opinion, the grant created a joint tenancy or joint interest, and not an interest in common. It followed, therefore, that in his opinion Gaulard's representative was not a proper party to the action, in so far as it sought an order for the assignment of the patents, inasmuch as the whole interest in the patents was vested in Gibbs as the survivor of the two joint patentees. The second and more difficult question was, assuming that Gibbs and Gaulard were jointly interested in the patents, what was the nature of the obligation created by the 7th clause of the agreement? Was it merely a joint covenant, in which case the only person who could be sued was Gibbs, as the survivor, or was it a several covenant, or a joint and several covenant under which either Gibbs or Gaulard or the representatives of either of them could be sued? His Lordship said that the words in the deed made the form of the covenant joint, and he did not feel justified in making it several. He came to the conclusion that the plaintiffs were not entitled to any relief against Gaulard's representative. Therefore, the action would be dismissed with costs, and the counterclaim would also be dismissed with costs, there being the usual set off. If it should be held that he erred in the view he had taken on the point which alone had been argued, it would be necessary that the action should be sent back in order that the other matters raised in the pleadings might be adjudicated upon.

Order accordingly.

Cock *v.* Elieson.

On Monday in the Queen's Bench Division, before Mr. Justice Day and a special jury, the case was heard of Cock *v.* Elieson. This was an action brought by the plaintiff, Mr. John Cock, against Mr. C. Prosper Elieson, an electrical engineer, for specific performance or in the alternative for damages for breach of an agreement dated July 30th, 1897, whereby the plaintiff agreed to purchase and the defendant to sell certain patents in relation to the driving gear and accumulators of motor cars. The defence was a denial that the defendant was called upon to carry out the agreement, as the consideration for its performance had not been transferred to him.

Mr. Jelf, Q.C. and Mr. D. Stewart Smith were counsel for the plaintiff, while Mr. Carrington represented the defendant.

Mr. Jelf, in opening the case for the plaintiff, said that the defendant represented that he was possessed of certain valuable patent rights connected with the mode of propelling motor cars, and he desired that a company should be formed. An agreement was accordingly made between him and the plaintiff, dated July 30th, 1897, by which Mr. Elieson was to make over all these patent rights to Mr. Cock, who was to sell them for £2,000 in cash and 53,000 fully paid up £1 shares in a company which was to be formed to work the patents, called the Elieson Lamina Accumulator Company, Limited. The consideration which was to be paid to Mr. Elieson for the patents was, first of all, a payment of £100 on the signing of the agreement, 10,850 fully paid up shares in the company were to be

allotted to him, he was to be appointed managing director of the company at a salary of £600 a year for five years from the date of the incorporation of the company, and a further sum of £900 was to be paid him by the plaintiff out of the sum received in respect of the shares of the company. The £100 was paid to the defendant by Mr. Cock on the signing of the agreement. The company having in the meantime been registered, Mr. Cock, on August 17th, entered into an agreement with the company, by which he was to receive a considerable sum for making over the rights in the patents to the company, the purchase to be completed on or before the following September 20th. Mr. Elieson became one of the directors of the company along with Mr. Fradd and two or three other gentlemen. The company was in a position to proceed with the business, but Mr. Elieson, when he was called upon from time to time to transfer the patents to the company, made all sorts of excuses. In the meantime Mr. Fradd, who was behind the plaintiff, had advanced something like £5,000 in financing the business. In the result, it was found quite impossible to get Mr. Elieson to sign the agreement and transfer the property, and at a meeting of the directors held on October 6th, 1898, a resolution was passed (Mr. Elieson protesting) to the effect that the solicitor to the company be instructed to take such legal proceedings as he might think fit to secure the formal transfer of the patents to the company. Upon that Mr. Cock being called upon to carry out his contract, brought the present action against the defendant. It was suggested by the defence that Mr. Cock was not ready to carry out his part of the arrangement, and that the purchase was not completed by the date agreed upon, time being of the essence of the contract. But it was completed at a date that was perfectly satisfactory to Mr. Elieson himself. Again, it was said that these 10,850 shares had not been allotted or transferred to him, therefore the plaintiff had not carried out his part of the agreement. But the fact was that these shares could not be transferred to the defendant until he had transferred the patents to the company, for the patents were the very consideration for which the shares were to be made over to the defendant. He should call evidence, and should then ask the jury to say that the plaintiff had made out his case, and was entitled to succeed in his action.

Mr. MARTIN FRADD said he came to know of the defendant's patents through Prof. Thompson. The defendant represented that the patents were of a valuable kind. Witness found the £100 which was paid over under the agreement, and he also found nearly £6,000 before any debentures were issued to him. He became one of the directors. Mr. Elieson was on the directorate, as were also Mr. Mackenzie and the Earl of Galloway. There were a good many meetings of the company, and questions arose about the making over of the patents. On October 6th, 1898, witness being in the chair at the meeting of the directors, he requested Mr. Elieson to assign over the patents to the company, but he refused to do so, on the ground that he had not got the £900. But that £900 was to be paid out of the sale of the shares, and the company could not sell the shares until they had got hold of the property. That was the difficulty all the way through. They could not realise the shares because the company would not give them over until it had received the patent rights for which the shares were to be the consideration. Mr. Elieson wanted to be paid the £900 before the thing was done by him which was to produce the £900. That absolutely produced a deadlock, and hence the necessity for passing the resolution of October 6th, 1898.

Cross-examined by Mr. CARRINGTON: You are a company promoter, and have promoted a great number of companies?—I have promoted one or two.

Your offices are at Sherburn Lane, where all the meetings of the company took place?—No, several of them took place at the works at Camden Town.

May I take it that at your office in Sherburn Lane you keep every sort of requisite for companies, from solicitors to directors, if necessary?—That is not so.

The vendor of this company, Mr. Cock, the plaintiff, was a nominee, or had a seat in your office?—Yes, that is so.

One of the directors proposed by you was Mr. Mackenzie?—He joined the board some time after the company was formed.

Was he a clerk in your office?—No.

Has he a seat in your office?—No.

Had he ever a seat in your office?—Yes.

But he has not now?—No; he was chairman of a company in my office.

Had he a seat in your office at the time these transactions occurred?—Yes.

Was the solicitor who prepared the agreement between Mr. Cock and the defendant a solicitor who had a seat in your office?—Yes.

My client is merely an inventor?—I do not know that he is merely an inventor. He is an electrical engineer. Witness, in reply to further questions, said he admitted that the 10,850 shares were not allotted to the defendant. They could not be allotted to him, inasmuch as the defendant refused to pass over the property in respect of which the shares were to be transferred. Lord Galloway had brought an action as a debenture-holder, and a receiver had been put in charge of the company's property.

Mr. MACKENZIE, another director of the company, having given corroborative evidence,

Mr. CARRINGTON addressed the jury for the defence, contending that there was no ground for this action. The defendant would, he said, have been only too glad to have transferred all his interests to the company, but he was never in a position to do so on account of the company not carrying out their part of the agreement. He was to receive certain sums for his patents, but, as a matter of fact, he never did receive these sums, and he was, therefore, quite right in declining to hand over his patents. He had never heard of a vendor who was supposed to hand over his property on the promise that he would get certain things. The shares were never allotted to him, nor was he ever formally appointed managing director, although he had been paid the salary agreed upon for his work. He had only been once called upon to assign his patents to the company, and that was at a meeting just immediately prior to the issue of the writ, and he declined to do so because he had not received the stipulated consideration.

The defendant was examined, and bore out his counsel's statement.

In the result the jury found a verdict for the plaintiff for specific performance, and also awarded him £50 as damages.

Judgment accordingly.

WORKMEN'S COMPENSATION.

THE case of Giddins *v.* the Strand and Charing Cross Electricity Supply Corporation came before his Honour Judge Lumley Smith, Q.C., in the Westminster County Court the other day, and was the first claim in this Court under the Workmen's Compensation Act.

Plaintiff, John Giddins, aged 52, a bricklayer, alleged that while employed by the defendant corporation an electric lamp burst in his hand. The voltage was 180 volts, and as a result of the burns and shock his left hand was paralysed, and his eyes and nerves affected.

Mr. POWELL, counsel for the defence, stated that he should allege plaintiff was suffering from complaints that had nothing to do with the accident. The claim was much exaggerated.

Medical evidence was given bearing that out, one doctor stating that he regarded plaintiff as "an alcoholic wreck." The voltage of the lamp in question was 100 volts—200 would not have hurt. In electrocution 2,000 to 3,000 volts were used, but there the "subject" completed the circuit. The chief engineer of the corporation produced a charged battery and showed the effects of various strengths of current on an incandescent lamp, inviting the Judge to test the shocking power.

His Honour declined the offer, and found for the plaintiff for £1 a week from when his wages stopped, with costs.

HODGE *v.* WOODWARD'S ELECTRIC STORAGE BATTERY, LIMITED.

IN the Westminster County Court on Friday, plaintiff sought to recover £21 odd for the cost of making tests and exhibiting a battery. Plaintiff's case was that the arrangement was made with gentlemen whom they believed were either directors or signatories to the articles of association. On behalf of the defendants it was said the promoters were liable. His Honour was not satisfied, and hearing Mr. Arthur Shippey was in Court, and knew something of it, desired him to be called, and this evidence showed that the tests made at the plaintiff's were those contained in the prospectus of the company. He had an account against the company. His fee for reporting upon the value of the battery was 52 guineas. What he did was done on behalf of the company.

His Honour gave judgment for the plaintiff for the amount claimed, with costs.

NELL *v.* BERRENBERG ELECTRIC LAMP SYNDICATE.

AT the Lord Mayor's Court last week, Mr. Kemp, Q.C. (instructed by Mr. Bryson), said his client, Mr. Nell, was suing to recover £197 17s. 8d., that was due from the Berrenberg Electric Lamp Syndicate. The plaintiff was the agent in this country for Messrs. Ball & Wood, of New York, who were the manufacturers of a tandem compound engine. The defendants had ordered one of the engines, and the plaintiff had agreed to supply one for £360. That sum was afterwards reduced to £305. The terms of payment were to be one-third cash with order, one-third on delivery, and the balance three months after delivery. The Common Serjeant said that from the papers before him it was clear that the case was not one that could be conveniently tried before a jury. The question to be decided was a highly technical one, and could be decided with more celerity, and more beneficially to the parties interested, by an engineering expert. The case was ultimately referred to the Registrar of the Court, a formal verdict being entered for the plaintiff on the claim, and for the defendants on the counterclaim, subject to a reference.

PARLIAMENTARY COMMITTEES.

MANCHESTER TRAMWAYS.

LORD LAUDERDALE presided over a Committee of the House of Lords to consider the Bill under which the Manchester Corporation seek powers to provide for the working of tramways in Manchester and outside the city by electricity or other motive power, to confirm agreements with outside authorities as to the purchase and taking on lease of outside tramways, and for other purposes. Opposition was offered by some outside authorities. Mr. Balfour Browne, Q.C., with Mr. S. Coward and Mr. G. Rhodes, appeared for the Bill; Mr. Fitzgerald, Q.C., and Mr. Roe-Rycroft opposed for the Salford Corporation; Mr. Pember, Q.C., Mr. Pembroke Stephens, Q.C., and Mr. E. H. Lloyd for the Stockport Corporation, and Mr. Wedderburn, Q.C., for the Eccles Corporation. The Swinton and Pendlebury Urban District Council also opposed.—Mr. Balfour Browne, Q.C., in opening the case, said the Manchester Corporation owned 56 miles

of tramways in the city, which were leased to the Manchester Carriage and Tramways Company. All the leases would have expired by 1901, and in view of that the matter was considered by a committee of the Corporation, and a report was issued in favour of the Corporation working the whole of the tramways. In May, 1898, the City Council passed a resolution to promote a Bill to enable the Corporation and any neighbouring local authorities to make arrangements for working tramways upon terms. In 1897 they got a Bill through Parliament authorising the Corporation to work the tramways in Manchester. In 1898 the Manchester Carriage and Tramways Company applied to Parliament for an Act to equip their lines with electricity, but the Bill was rejected. The Corporation had agreed with Failsworth, Audenshaw, Droylsden, Gorton, Denton, Levenshulme and Heaton Norris, in regard to the working of the tramways, and one of the objects of the Bill was to confirm the agreements that had been voluntarily entered into on the question with these authorities. No agreement had been entered into with Stretford, Moss Side and Withington Urban District Councils that Manchester should work their trams. The real opponents to the Bill were the Stockport Corporation. He was not sure that the Salford Corporation offered a serious opposition.—Mr. Roe-Rycroft said that the Salford Corporation wanted Eccles and Swinton excluded from the Bill, as they considered these places were natural adjuncts of Salford.—Mr. Balfour Browne, Q.C., remarked that if that was all Salford wanted, Manchester would not seek powers to enter into such agreements with Eccles and Swinton.—Mr. Wedderburn, Q.C., on behalf of Eccles, said supposing Eccles got powers to run trams to the Manchester boundary, he asked that Manchester would allow Eccles to run trams over a length of half a mile up to Deansgate in the city.—Mr. Roe-Rycroft objected to Eccles having running powers over the lines of the Salford Corporation, and suggested that it was competent for the promoters of the Manchester Bill to strike out Eccles.—Mr. Balfour Browne said he had no doubt there would be a voluntary arrangement between Eccles, Salford and Manchester by means of which people from Eccles would be carried into the centre of Manchester, but he was not going to force anybody into an arrangement. With respect to the opposition of Stockport, he contended that Stockport had no right to be heard. Stockport had a tramway 6½ miles in length, three miles of which was in Manchester, one mile in Levenshulme, one mile in Heaton Norris, and a mile and a half in Stockport. It was absolutely agreed that the three miles in Manchester should fall into the hands of the Manchester Corporation as well as the short lengths in Levenshulme and Heaton Norris, but Stockport wanted to upset the agreement between Manchester and Heaton Norris, and the Corporation of that borough urged that they had a right to be heard against such an arrangement. This he absolutely denied.—Alderman Lloyd Higginbottom, chairman of the Electricity Committee, showed how the tramway system could be worked as one continuous whole by electricity. When the whole system was working in this way, he said the price of electrical energy for the tramways would be considerably reduced. It would be to the advantage of the outside authorities that there should be one continuous system worked by Manchester; in fact, it would not be possible to work lines economically otherwise.—Mr. C. W. Nasmith, chairman of the Heaton Norris Urban District Council, also gave evidence in support of the Bill.—As the Committee did not wish to hear any expert evidence relative to the scheme, no other witnesses were called for the Manchester Corporation.—Mr. Wedderburn, Q.C., asked, on behalf of Eccles, to be left in the Manchester Bill, but that any future agreements should receive the sanction of the Board of Trade. He also asked that in a certain event that borough might be entitled to have running powers into Manchester.—The Mayor of Stockport (Mr. Webb) afterwards gave evidence on behalf of Stockport against the Manchester scheme, and gave it as his opinion that if the agreements proposed were made Stockport might be isolated entirely, and there might be a refusal to make any agreement for the continuation of the existing through lines. In reply to Mr. Coward the witness said Stockport had no objection to entering into an agreement with Manchester, but they wanted to have the agreement made compulsory.—The Committee, after hearing the points raised by counsel, deliberated in private, and the chairman afterwards announced that the preamble was proved and that the Bill could proceed. The Committee decided that Swinton and Pendlebury should be left out of Bill, but that Eccles should remain in.

The clauses of the Bill were subsequently considered and passed.

Oldham Corporation Tramways Bill.

A Select Committee of the House of Lords, presided over by Lord Lauderdale on Tuesday, had under consideration a small general purposes Bill, promoted by the Oldham Corporation for the purpose of making new tramways, reconstructing some of the old existing tramways in the borough, entering into financial arrangements consequent upon the works proposed, and for other purposes. Mr. Pember, Q.C., and Mr. Frere appeared for the promoters.—Mr. Pember, in entering into an explanation of the scheme, said the Corporation wished to be empowered to construct additional tramways, make streets, and to have conferred upon them further powers with regard to tramways in and near the borough. There were seven miles of tramway belonging to the Corporation which were leased separately by the Manchester Carriage and Tramways Company and the Manchester, Bury, Rochdale and Oldham Company, the leases of which would fall in in 1901. When the Oldham Corporation proposed to take them, a short branch line would be constructed to join the two systems. They were estimated to be worth £71,000, while the total cost to the Corporation would amount to £100,000. According to one section of the Bill the Corporation would have power to work the tramways in Royton, Crompton, and Lees. The British Electric Traction Company, who were represented by Mr. Balfour Browne, Q.C., petitioned against the Bill. This company was entitled under a light railways order to construct certain light railways from Little Heaton to a point in Middleton Road in the borough, and covered streets to be traversed by the proposed new tramways. The Committee, after hearing the argument for and against the Bill, decided that the preamble was proved and allowed the Bill to proceed.

Manchester Electric Lighting Powers.

Sir Stafford Northcote presided over a Select Committee of the House of Commons on Tuesday, to consider the Omnibus Bill promoted by the Manchester Corporation, which contained a provision for supplying electricity to local authorities "in the neighbourhood of Manchester." The Manchester Corporation already has powers by a former Act to supply electricity to districts "adjoining Manchester." By this Bill it sought to obtain powers to supply districts which did not adjoin but which were in the neighbourhood of Manchester. The intention was to supply electricity to districts over which the Manchester Corporation tramways would run.—Alderman Higginbottom gave evidence, and in reply to the chairman as to what price would be charged, said the Corporation only desired to supply electricity by agreement with the local authorities. The local authorities must first get their provisional orders and secure powers to transfer them to the Manchester Corporation, after which the Corporation would be prepared to supply electricity at the same price they charged inside the city.—The chairman asked what would be the result in the future when the charge inside the city might be reduced?—The witness said it would be agreed with the districts that they were always to charge the same price as that inside the city, and he saw no reason why they should want to do otherwise.—The Committee passed the clause.

CORRESPONDENCE.

Interior Conduit Wiring.

As you have invited a discussion on the above subject, I venture to give the results of several years' experience of various conduit systems. Some time ago you published a series of papers in favour of uninsulated iron pipe for the above work, and as there were many misleading statements therein, I propose to refer to both sets of articles at once.

If it is desired to have the "absolutely best" installation irrespective of cost, there is certainly no competitor near the steel-armoured conduit, for the same wire may be used in each, and the interior insulated tube is just as strong as the bare pipe, while there is no doubt that (1) there is less danger of damaging the wire during insertion, and (2) the insulating coating *must* reinforce the insulation to earth even of the best wire.

I consider it very doubtful whether the enormous extra outlay is counterbalanced by these advantages, and I consider that a *really well* installed bare pipe system cannot be much improved upon.

The principal factor determining the quality of an installation is the labour, for, while a good man can make a good job with poor material, a bad man *will* make a bad job whatever he works with. Certainly, given a bad or careless workman, the chances are much in favour of the insulated conduit. I believe if the truth were known, the success of the insulated conduit is altogether due to bad work of the men who instal the electric pipes and wires.

The success of a pipe job depends upon two things: Careful laying out and good work. In erecting bare pipe, each piece should be examined for internal burrs and projecting edges. After cutting, the inside should be carefully cleaned from oil and the end filed out or reamed smooth.

If possible, it is an advantage to round the inside edge slightly.

The screw thread should be carried far enough down the pipe to allow the two pipes to meet in the centre of every socket or coupling. As gas piping is always supplied with one socket on each length, this *must* be taken off and the end prepared as above. No red lead or other oily substance should be put on the thread until the pipe has entered the socket.

It is absolutely impossible to plan a job (except as regards arranging the lamp circuits), without being actually on the job. It is silly to talk about cutting pipe and fitting it and

then taking it on to a job as though a building was built correct to a 64th of an inch.

This necessity for careful work disposes of the "cheapness in erecting" argument in favour of uninsulated pipe. It is morally impossible to get a man, used to the slap-up and go anywhere and anyhow gasfitter methods, to grasp the principle of conduit pipe work, which must be most carefully done.

In criticising a system, it is well to have more than a price list acquaintance with it, and had your writer on unlined pipe taken this fact to heart, he would not have spoken of sleeve joints on armoured pipe. It is true the plain and brass-covered pipe have sleeve joints, but the steel armoured pipe is screwed, though with a finer thread than the ordinary Whitworth.

In describing a system as an encouragement to the jerry wirer, it is well to remember that a length of wire can be drawn out anywhere and examined, and a consulting engineer who failed to take advantage of this would deserve to be gulled.

In speaking of joints, it is well to notice that any good installation nowadays should have *no joints*, therefore no vulcanising is needful.

I introduced a system some years ago, which has since given great satisfaction, of using a three-contact ceiling rose, and connecting as follows:—Lead from fuseboard and lead to next light, and one wire to switch on one contact plate. Return from fuseboard and return from next light, and one side of flex cord or fitting wire to another contact plate, and the other switch wire and the other wire of flex cord to third contact.

This does away with all joints, and makes a very good job.

Another thing in the article referred to which needs modification is the statement that "the fewer bends and the more boxes used the better."

One of the greatest nuisances in conduit work is explaining to architects, clerks of works, and builders' foremen the necessity of intersection and other boxes, and getting permission to have traps left in floors, and to put these boxes in walls, &c., when they *have* to be used. It also requires very great care to get them fixed so as to be just flush with plaster, and my experience is that all these boxes are to be avoided like poison. I utilise bracket outlets and switch points as much as possible for intersection points, and have carried out large jobs without more than half a dozen boxes on the whole system.

Another very foolish recommendation is to drill a hole through a pipe where it bends down. Nothing is more certain to tear and cut the wire when being drawn in than a hole in the position shown, as this is just where the very greatest friction between pipe and wire exists. Everyone knows what a sharp edge is left on a sheet of iron round a newly drilled hole.

Reference is made to the inspection fittings used in a rival system.

I have had a lot to do with these, and admit their convenience for surface work, but how are they to be used in concealed work? They are not adapted to fit flush with plaster, and could only be used inside a trap in a floor or a box in a wall. Of course they look very nice when seen in a price list. A great fault in the same system is the method of jointing. The sockets and bends are bent metal brazed and bored out, and as the metal is not always truly bent or bored, much inconvenience is caused when threading a tape through, and there is great risk of damaging wire in drawing in.

As regards bending pipe, I can add my testimony to that of Mr. Butt. I find that there is not the same tendency to flatten at the bend that there is with unlined pipe, and this is, of course, a great advantage. I may also support his statement as regards moisture.

There seems to be some misapprehension also as regards the burr formed when cutting pipe. If a pipe cutter is used, this burr is certainly formed, but whether sawn or cut in usual way, the burr is completely removed if the reamer supplied by the conduit company is properly applied.

Trusting I have not trespassed too far upon your valuable space, and that this important matter will be once and for all threshed out.

W. H. Isherwood.

Two-Phase Motors.

I beg to ask the aid of your columns regarding the following difficulty I have met:—

As a draughtsman with one of the leading electrical firms, I have recently been trying to master the principles underlying the calculations necessary for two-phase motors (induction).

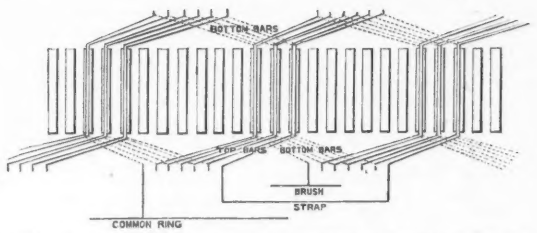
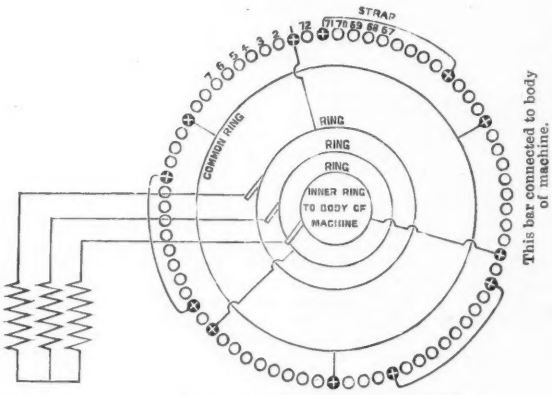
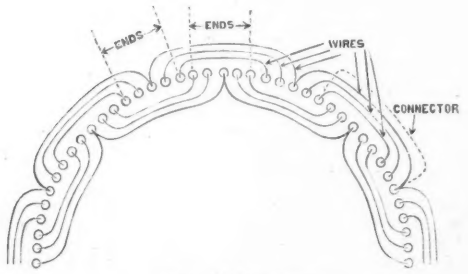


Diagram showing one section of armature winding; 3 sections in all, 96 bars per section in series; 288 bars in all approx. sect.



Resistance.

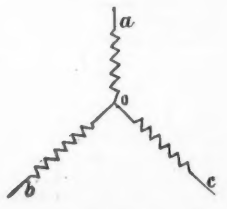
Diagram showing armature end connections.



Field winding diagram.

I have got on all right with one exception, and it is with this exception I ask your aid; as, though I have asked the aid of several well-known engineers, none of them were able to help me.

Two-phase motors are often wound on the armature or rotor with a "star" winding, and I have been unable to do



the necessary calculations for such a rotor. I got on all right with short-circuited rotors, and also those with two or more entirely separate circuits.

I have hunted through all the books and papers I could find, but though I got plenty of information about short-circuited rotors, and also the formation of a "field" by a "star" winding, I found nothing about such a winding on the rotor.

I here give you a diagram. I also enclose a print of this winding as used on a motor.

a, *b*, and *c* are connected to the slip rings, and *o* is a common connection. In a two-phase motor what would be the E M.F. produced in a rotor wound thus, what would be its equivalent resistance and what would be the watts lost in such a winding? I really wish to know how to calculate such a winding to give a certain power.

This seems to be a puzzle for most practical men, but possibly some of your readers will solve the problem for me.

Thanking you in anticipation of your help,

E. C. Wilson.

Electric Piping.

It is very clear that before long wood casing will be as extinct as wood cleats and metal staples are at the present day. Having used several kinds of conduit systems, I have come to the conclusion that the "Simplex" tubing is by far the best and cheapest in the market.

In my opinion insulated pipes are quite unnecessary unless it be for outside use. I do not agree with Mr. Butt using an inferior insulation and relying upon the insulated pipe for the insulation test. It is far better to have a highly insulated wire and not depend upon the pipes for insulation.

The main items to be considered by the contractor are —cost, labour, and a satisfactory test.

Insulated iron pipes *v.* Simplex :—

1. The cost is very great.

2. They require to be "let into" the walls, the external diameter being so large, owing to the insulation inside.

3. They require to be screwed, and are very awkward to work in some places, owing to bends, unless a long thread is made and the pipes cut to a right length so as to run the union first one way and then back again to meet the other pipe.

4. The unions are so big, and if struck with a hammer the paint is liable to be damaged, and then they rust through the plaster, and are an endless trouble. I agree with Mr. Butt that it is a fine system, and the bending of pipes is quite easy, but the system is too clumsy to be fixed on a 4½-inch brick wall; for instance, in a private house division wall.

Brass and composition tubing are out of the question, as they have no mechanical strength, and do not prevent nails, &c., being driven through them.

In my opinion, the "Simplex" tubing is all that can be desired. It is cheap and strong, and the interior is very smooth, the bends are sometimes rather rough, but they can be detected and not used. The system if carried out with the accessories supplied by the makers, makes the finest installation that can be desired, and jointing is done away with if "looping" is used, wherever possible, of course, it is advisable to solder the loops to get a through connection.

The worst thing about the "Simplex" is the bending, it is impossible to bend it neatly. I have tried several ways without success.

I may mention I have no interest in the Simplex firm, and only speak from experience. No electrical engineer would use gas barrel for any length owing to the roughness of the interior.

Junction boxes are not made in enough patterns at the present time, but demand will soon make this good.

Wishing the conduit system all success, and that condensation will not play the same tricks it has done with bell installations.

Jno. G. Burchell.

Permit me to make a few remarks, *re* piping for installations.

My long and varied experience of casing of various descriptions has been that, until quite recently, most of the systems in the market were most unsatisfactory; take, for example, the common or garden gas piping, it is both heavy to put up, clumsy and unsightly in appearance, and is also dirty to fit up, consequent upon the red and white lead at the joints, and also the rough exterior. Or, again, that highly respectable but antediluvian wood casing, which looks very well when painted, but alas, *how* often is this, in new installations in old buildings? It cannot fuse, certainly, but if it once gets wet through, it has a very detrimental effect on the wires.

In my estimation, after using it under many and varied conditions, there appears to be no better casing or piping than the conduit manufactured by the Simplex Steel Conduit Company, of Birmingham. By reason of its being constructed of steel, the weight of the conduit has been materially reduced, thereby making an article handy to work, and neat in appearance. Its great recommendation, however, is, I find, in all the T-pieces, bends, boxes, and sockets, &c., being bored in a lathe, so that the conduit fits accurately into them, making a very neat joint, without the requisition of any screwing whatever, thus effecting a saving of 50 per cent. of the time required in putting up an installation, which is a very great consideration in the cost of a contract. It is certainly, in my opinion, *the* conduit of the future, as it is possible to effect a tremendous saving of time and labour.

The interior of the conduit also is so beautifully smooth and clean, through being enamelled inside as well as out, that there is no fear of any abrazement of the wires. Another of its advantages is described as "Inspection" parts, such as boxes, Ts, bends, &c. These have close-fitting flat covers, easily removable, to facilitate drawing wires through or inspecting same.

This system, which is simplicity itself, seems, to *my* mind, to have solved the problem of a good permanent mechanical protection for wiring.

With apologies for encroaching on your valuable time and space.

Harold E. Owen, E.E, M.I.M.E.

London.

Signalling on Single Lines of Railway.

I beg to assure Mr. Hollins that there was no intention of conveying the impression that an alternative method to his, of dealing with non-passing staff stations, had been devised by "merely breaking the lines." Neither was it intended to *convey* the impression that any such device existed.

What it was intended to show was, that the interdependence effected by Mr. Hollins's apparatus is created by regulation under other, but not dissimilar conditions, and that this offered a basis for approaching the problems which have to be solved.

The Writer of the Article.

A Hint to Oxford.

As a regular reader of the ELECTRICAL REVIEW, I notice, with great interest, the picture on page 669 of the current issue of that, and trust that it will be read by not a few people residing in Oxford. I write this epistle duly mindful of the arduous labours of Mr. Edward Williams-Byron-Nicholson, M.A., of Bodleian Library fame, in behalf of the overworked tram horses of Oxford, and I feel sure that if but a few of your readers residing in Oxford knew as much as I do of that gentleman's untiring energies in behalf of Oxonian tram horses they would, I feel sure, combine with him in getting the aforesaid picture to be realised in Oxford. I notice that at Birmingham, Liverpool, and other large towns, electricity and steam are used as the motor power for the tramways, and I cannot for the life of me see why Oxford should stand aloof from adopting the best and latest improvements in connection with her tramways unless, perhaps, that she is still heedless to the sufferings of the poor overworked and overloaded horses of her tramway company, and also of the comfort of her poor sweltering folk packed together in a close stuffy atmosphere, and then, even when a car is as full as it is entitled to be, the conductors and drivers permit any amount more passengers to embark, I suppose, for the sake of getting extra fares and of further adding to the discomfort of previously taken up passengers.

Now, as I know that Oxford already possesses electric light works, and that the electric light mains can supply motive power for working tramcars as designed in the aforesaid picture, by being connected with the car either from above or from beneath, there should be no difficulty in adopting the system advocated as aforesaid by the ELECTRICAL REVIEW, and then the tramway company at Oxford would be spared the trouble of having to buy, tend,

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house, and keep a quantity of horses, and, on the other hand, "overloading" would not so often be laid at the doors of the Oxford Tramway Company as it now is.

I might add as a further reason for adopting the tramcars as designed in the aforesaid picture, that in dear old picturesque Oxford the ugly advertisement-covered cars as at present used are a most repulsive eyesore, but that consideration I suppose may be lost on the majority of your readers, who like to know that "Leather's boots are the best," or that "Froth's soap is matchless for the complexion."

Henry James Saint Benno Cunliffe, M.A., Oxon.

May 2nd, 1899.

BUSINESS NOTICES, &c.

Auction Sale.—Yesterday Messrs. Fuller, Horsey, Sons and Cassell offered for sale by auction at Greenland Place, Camden Town, the electrical plant, motor cars, &c., of the Elieson Lamina Accumulator Company.

Bankruptcy Proceedings.—On the 28th ult. the public examination of J. E. Stott, electrician (J. E. Stott & Co.), was opened at the Bankruptcy Court, Huddersfield. The examination was adjourned until June 12th pending the settlement of a dispute in regard to a contract.

At the Sheffield Bankruptcy Court last week a discharge was granted (with a suspension for two years) in the case of J. H. Dewhurst and G. Longden (John Dewhurst & Son, mechanical and electrical engineers).

Liquidations, Dissolutions, &c.—The Direct Electric Generator Syndicate and the Direct Electric Generator (Foreign Rights) Syndicate, Limited, are both to be wound up voluntarily. Mr. P. Mason, of 64, Gresham Street, E.C., is liquidator of both concerns.

We are informed that Messrs. G. R. Blot & Co., Limited, are in liquidation. Messrs. Fairbairn & Wingfield, 64, Cannon Street, E.C., are liquidators.

Books Received.—"Fire Tests with Glass"; three casements glazed by the British Luxfer Prism Syndicate, Limited. The British Fire Prevention Committee's report. 1s.

"Transactions of the Society of Patent Agents." 1898. 50, Chancery Lane, W.C.

Business Announcement.—Messrs. Percy Huddleston and Co. have sold by auction to Messrs. W. R. Edwards and S. F. Beevor (of the Thames Valley Launch Company, Limited), the lease, goodwill, and business of the Upper Thames Electric Launch Company, carried on by E. W. Bowles, at Henley-upon-Thames. See our "Official Notices" this week.

Catalogues, Lists, &c.—From the Electrical Company, Limited, we have received a list giving prices and illustrations of lampholders for various purposes. We have also received from the British Electric Meter Company, of Aldersgate Street, a pamphlet containing an illustrated description of the Bastian patent electricity meter, and some notes on its advantages.

The Crystal Electric Lamp and Rose & Bird, Limited, have issued an illustrated catalogue of their several classes of incandescent lamps and terminals, giving revised prices of same.

From Messrs. W. N. Brunton & Son, of Musselburgh, we have received a list giving a table of sizes, weights, &c, of mild steel wire. Another table is given, compiled by Mr. Brunton, on a method for calculating tons per square inch.

Mr. Emil Passburg, of Berlin, sends an illustrated list of his patent vacuum drying apparatus for rapidly and economically drying electric cables, dynamos, India-rubber, and chemicals used for vulcanising, &c.

Change of Address.—Mr. A. C. Eborall has removed from 11, Queen's Road, Chelsea, to 104, Upper Tulse Hill, S.W.

Clutterbuck v. London Electric Supply Corporation, Limited.—In the Westminster County Court, Judge Lumley Smith, Q.C., and a jury, had this case before them on Wednesday. It was a claim by Geo. Clutterbuck, keeper of coffee and dining rooms at 1 and 1a, Queen's Road, Peckham, for 10 guineas damages for loss of business and damage to concrete by protracted excavations carried out in front of his premises by defendants while laying electric light mains. 30s. was paid into Court. The jury found for the plaintiff for £4 10s., including the 30s. in Court, and judgment was given accordingly, with costs.

Staff Concert.—A grand Bohemian concert was given by the staffs of the City of London, the Metropolitan, and the London Electric Lighting Companies, on Friday, April 28th, in the Grand Hall, Freemasons' Tavern, J. Cecil Bull, Esq., presiding. The artistes were Madame Kate Cove, Miss Jessie Hotine, Miss Emily Foxcroft, Mr. Dalgety Henderson, Mr. Charles Tree, the Field-Fisher Quartette, Mr. Mel B. Spurr, Mr. Charles Conyers, Mr. Walter G. Churcher, Mr. John Warren, and Mr. Sidney Hill (accompanist). A very pleasant evening was spent, about 800 being present.

Electrical Wares Exported.

WEEK ENDING APRIL 26TH, 1898.

		Value
Adelaide		£122
Alexandria		25
"	Teleg. mat.	205
Amsterdam		110
Bangkok		13
Barcelona.	Teleg. mat.	41
Beira.	Teleg. mat.	47
"	Teleph. mat.	372
Bombay.	Teleg. mat.	416
Bordeaux.	" "	74
Boulogne		67
Brisbane.	Teleg. mat.	1,251
Buenos Ayres		280
Calcutta		344
Cape Town		292
Christiana		40
Colombo		83
Copenhagen		75
Delagoa Bay		490
Demerara		8
"	Teleg. mat.	104
Durban		934
"	Teleg. mat.	1,780
East London		215
Flushing		49
Fremantle		105
Hamburg		135
Lisbon		15
Malaga		353
Melbourne		332
North Sea.	Teleg. cable	5,996
Oamara		858
Piræus		110
Port Elizabeth		107
Porto Alegre.	Teleg. mat.	30
Rio Janeiro.	" "	4,704
Saigon		20
Santander		50
Shanghai		37
Stockholm.	Teleg. mat.	165
Sydney		966
Townsville		400
Trieste.	Teleg. mat.	400
Vera Cruz		57
Wellington		291
"	Teleph. mat.	337
Total		£22,919

WEEK ENDING APRIL 25TH, 1899.

		Value
Alexandria		£10
"	Teleg. stores	50
Amsterdam		75
Bombay		50
Boulogne		51
Buenos Ayres		1,100
Calcutta		885
Cape Town		164
Colombo		138
Copenhagen		110
Demerara		13
Durban		964
"	Teleg. mat.	1,716
Gothenburg		88
Hamburg		225
Madras		186
Mauritius		25
Melbourne		95
"	Teleg. mat.	4,421
Odessa.	Teleg. mat.	50
Otago		42
Port Elizabeth		397
"	Teleg. mat.	75
Rotterdam.	Teleg. mat.	35
Shanghai		102
Singapore		96
Sydney		254
Tientsin		14
Wellington		111
"	Teleg. mat.	89
Yokohama		130
Total		£11,261

Foreign Goods Transhipped.

New York		£177
Melbourne.	Telephones	£44
Trinidad.	Elec. light apparatus	83
Total		£131

Electrical Wares Exported.

WEEK ENDING MAY 3RD, 1898.

		Value
Amsterdam		£25
Auckland		43
Barcelona		298
Bordeaux		18
Boulogne		169
Calcutta		42
Cape Town		1,673
Durban		466
"	Teleg. mat.	672
East London		81
Flushing		19
Fremantle		200
Lisbon		402
Mauritius		73
Melbourne		35
Monte Video		50
Penang		24
Port Elizabeth		410
Stockholm.	Teleg. mat.	435
Sydney		148
Yokohama		1,898
"	Teleg. mat.	3,000
Total		£6,631

WEEK ENDING MAY 2ND, 1899.

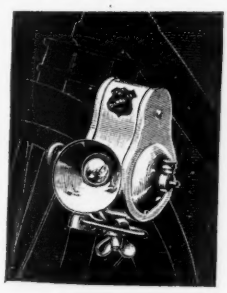
		Value
Adelaide		£280
Amsterdam		71
Auckland		99
Bahia.	Teleg. cable	19,567
Bangkok		10
Boulogne		51
Buenos Ayres		2,018
"	Teleg. mat.	320
Calcutta		648
Cape Town		536
Colombo		61
Durban		340
East London		111
Gibraltar		17
Gothenburg		94
Halifax		589
Hamburg		150
Hong Kong		864
Melbourne		174
"	Teleg. mat.	640
Montreal.	Teleg. wire	58
New York		137
Odessa.	Teleg. mat.	30
Piræus		183
Port Elizabeth		161
Port Said		8
Stockholm.	Teleg. mat.	273
Sydney		365
Teneriffe		25
Vladivostock		130
Total		£27,497

Foreign Goods Transhipped.

Barbadoes.	Teleph. mat.	£43
Barcelona		11
Flushing.	Elec. apparatus	£15
Stockholm.	Teleg mat.	20
Total		£35

The "Dynolite" Cycle Lamp.—The Electrical Inventions and Manufacturing Company, Limited, of Manchester, have sent a specimen of the "Dynolite" electric cycle lamp, comprising "generator," bracket, lamp and reflector. The generator is constructed with modifications that make it suitable to the peculiar conditions under which it has to be used on a cycle. The magnetic field is formed of permanent magnets between the poles of which rotates an armature of a special design, so wound that while it generates sufficient current to give light at low speed, does not materially increase the voltage, however high the speed may become, and so avoids injuring the incandescent lamp. The armature spindle runs in long bearings, which are efficiently lubricated. On an extension of the armature spindle is mounted a small pulley, in the groove of which fits a rubber ring that can readily be replaced in case of wear. This rubber-tyred pulley is brought into contact with the rim of the front wheel of the cycle, which transmits the movement to it and causes the armature to revolve. The body of the generator is mounted on bearings, so that it has a rocking movement at right

angles to the wheel; this rocking movement being controlled by a spring that tends to press the above-mentioned pulley against the rim. By this means, irregularities in the shape of the rim (the variations from a true circle) are allowed for, and no undue pressure or strain is put on the spindle. This rocking movement is also made use of to throw the pulley out of contact with the rim, when the light is not required. The external case of the generator is of polished aluminium. It is mounted on a bracket of light and strong construction, that is fixed to one of the front forks by a band



clip. A cycling member of our staff has been trying the lamp for some time and reports favourably on it. It gives a steady light at 3 to 4 miles an hour, and apparently reaches its maximum brilliancy at about 8 miles an hour The jolting on suburban roads seems to have no effect on it, and even at the pace of a crawling hansom the light emitted is evidently sufficient to fulfil the requirements of the law as even crossing at Charing Cross at a snail's pace right in front of the man in blue no objection was taken to the temporary dimness of the light. To our cycling friends it should be of interest as a solution of a problem which has exercised the minds of many of them. It is ingenious, and unlike many ingenious contrivances, so far as it has been tried it is reliable.

The City Electric Lighting Contracts.—Mr. Algar presented a report from the Streets Committee to the effect that a further opinion of counsel had been obtained in regard to the electric lighting contracts. It was recommended that a copy of the opinion should be forwarded to Sir Courtenay Boyle with a request that he would delay for the present his report upon the recent public inquiry. The committee stated in their report that, in addition to obtaining an opinion from Mr. Danckwerts, they had consulted Mr. Swinfen Eady and Mr. Warmington on the validity of the present contract. Counsel had conferred with Mr. Danckwerts, and the report of the learned counsel was as follows:—

The following are the material dates of the facts upon which we are asked to base our opinion:—

May 19th, 1890.—Brush Contract (Central District) with Commissioners of Sewers.

May 28th, 1890.—Laing-Wharton Contract (Eastern District) with Commissioners.

August 18th, 1890.—Brush and Laing-Wharton orders confirmed by Parliament.

February 5th, 1891.—Brush Contract (Western District). Formation of Pioneer Company.

February 6th.—Contract between Pioneer and Brush Companies, ditto Laing-Wharton Companies.

February 10th.—Alderman Sir Joseph Savory registered as holding 25 shares in Pioneer Company.

February 10th.—Mr. MacGeagh, C.C., registered as holding one share in Pioneer Company.

February 11th.—Alderman Sir Joseph Savory registered as holder of 200 shares in Brush Company, Brush divisional order (Western District).

March 4th.—Alderman Sir Joseph Savory sells 40 Brush shares.

March 11th.—Alderman Sir Joseph Savory sells 160 Brush shares.

City of London Electric Lighting Company formed.

July 13th, 1891.—Contract between City Company and Pioneer Company.

July 15th.—Mr. MacGeagh registered as holder of 28 shares in City Company.

August 21st.—By indenture this date, undertaking under Brush orders 1890 and 1891; Laing-Wharton order 1890, and contracts May 19th, 1890, May 28th, 1890, and February 5th, 1891, transferred to City Company.

August 16th, 1892.—Alderman Sir Joseph Savory registered as holder of 250 shares in City Company.

Mr. MacGeagh was in and after February, 1891, a Common Councillor and Commissioner.

Under the above circumstances, we have no doubt that the two Brush contracts with the Commissioners of Sewers and the Laing-Wharton contract with the Commissioners, which were transferred to the City of London Electric Lighting Company, are null and void.

Mr. Algar moved that the Court should agree with the committee in their report, and the Court agreed.

The Town Clerk read a letter which had been received from the City of London Electric Lighting Company suggesting a meeting between the Streets Committee and the company. The letter, which was dated the 12th ult., and signed by Mr. Cecil Bull (the secretary), stated that at an informal interview between a representative of the company and some members of the Streets Committee on the previous day it was suggested that a meeting should take place between the company and the committee, and that a frank interchange of views would be of benefit to both sides. The board of the company, the letter concluded, would be happy to meet the Streets Committee in the matter.

Mr. Turner moved that the letter should be referred to the Streets Committee for the members to obtain the opinion of the City Solicitor, and to act accordingly.

Major Dunfee having seconded the motion,

Mr. Brooke-Hitching moved that the Streets Committee should be instructed to seek an interview with the company. The committee, he declared, was bound to adopt that course, as it was a natural one to pursue. If the Corporation was ever to possess the control of the electric lighting in the City, it was time that that body opened negotiations with the electric lighting company. If that course was not adopted it would be for the committee to consider whether they should recommend the introduction of a competitive supply. The fact was, Mr. Brooke-Hitching said, that the Corporation was now in an *impasse*.

Mr. Deacon, in seconding the amendment, said it was a natural and businesslike course to pursue.

Mr. Judd reminded the Court that it was essential that the Court should view the position as men of business, more especially as the difficulty of the situation had been added to by reason of the opinion of counsel that the existing agreement was null and void. Let the Corporation, he said, meet the representatives of the company, and endeavour, to the best of their ability, to settle the important question in which the citizens were so largely interested.

Mr. Deputy Johnson objected to the use of the word "instructed," as he did not wish to tie the hands of the committee in any way.

Mr. Morton asked the Court not to forget that the Corporation was now out of bondage, it having obtained its freedom owing to the action of some members of that Court. Having recovered its freedom—which ought never to have been lost—the Corporation should be extremely careful that it did not give its freedom away again. Attempts, he declared, had been made to increase the price of the shares of the electric lighting company, it being alleged that the Corporation was going to buy up the undertaking on the company's own terms. Mr. Morton said that, so far from any negotiations having taken place prior to the Board of Trade inquiry, the company had absolutely defied the committee until counsel had declared that the existing agreement with the company had been rendered null and void. He then explained how the informal meeting took place at the Guildhall between representatives of the company and some members of the Streets Committee. The chairman (Mr. Algar) was spoken to on the subject, and, with his usual courtesy, he (the chairman) invited the representatives of the company into a committee room, and, after hearing what they had to say, informed them that any suggestion they had to make must be put in writing and addressed to the Town Clerk. Mr. Morton then moved that the consideration of the letter should be postponed for a month, adding that it behoved the Corporation to act most carefully in the matter.

Mr. Brooke-Hitching said he very readily withdrew his motion in favour of Mr. Morton's.

Mr. Moojen, in seconding Mr. Morton's proposition, said he regarded the letter from the company as an attempt to go behind the inquiry which had been held by Sir Courtenay Boyle. While the whole question was *sub judice* it would be not only unfair but most irregular to enter into negotiations with the company.

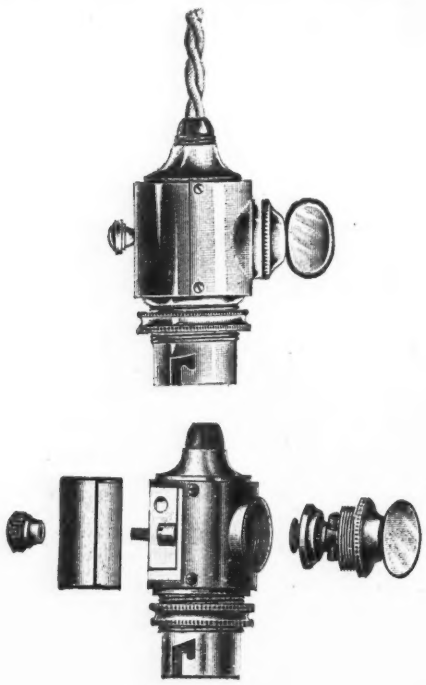
Mr. Morton's motion for the adjournment of the matter for one month was then adopted by a sweeping majority.

Extension of Premises. — The Hart Accumulator Company, Limited, has just extended its works at Stratford.

Hammersmith Electricity Extensions. — In our recent article on the extensions at the Hammersmith electricity works we mentioned that the cables were of Callender's manufacture. As a matter of fact all the mains for the new, as well as under the original contract, have been manufactured and laid by the Callender's Cable and Construction Company, Limited. These contracts covered the supply and laying of the high tension feeders and arc light cables, and all the low tension distributors. They also included the erection of the arc lamp-posts and the fitting up of the sub-stations. The new feeders which have been laid have a total length of about 5 miles, and have supplied 10 sub-stations. They are drawn into cast-iron pipes which were laid by the Callender Company, and consist of concentric cables, insulated with bitumenised fibre, and lead sheathed, being finished by a strong braiding over the lead. The longest of these new feeders is taken from the generating station *viâ* Fulham Palace Road and King Street to a new sub-station which has been built at Young's Corner, close to the Chiswick boundary line. This cable has a total length of about 1½ miles, and the sectional area of each of its conductors is ·1 square inch. On its way it taps the sub-stations at the Grove and Holcombe Street. The other new feeders vary in sectional area between ·10 and ·05 square inch, and are run from the generating station *viâ* Great Church Lane to Hammersmith Road; from the Town Hall to Brook Green; from Shepherd's Bush sub-station *viâ* Goldhawk Road to Stamford Brook Road; and from Shepherd's Bush sub-station *viâ* Uxbridge Road to Askew Road. These new sub-stations have been fitted with the special form of high tension cut-out box made by Messrs. Callender. Fuses are provided which are attached to porcelain supporting pieces provided with handles, which pieces fit into clip contacts, and can easily be removed, so that any feeder or transformer can be detached from the bus bar without interfering with any other feeder or transformer. *Low Tension Distributors.*—About 7 miles of new distributors have been laid, sizes varying from ·3 square inch to ·15 square inch. They are concentric cables, insulated by bitumenised fibre, lead sheathed, yarned, armoured by two steel tapes, yarned and compounded, and are laid direct in the ground, being further protected by bricks which are placed dry over them. The ends of these cables are brought into the sub-stations and are connected through cut-out boxes to a bus bar, and they are provided with cut-out apparatus of the same type as that used for the high-tension mains. *Arc Lamps.*—60 new arc lamp-posts have been erected, and a complete new circuit has been run from the central station, which consists of about 5 miles of 7/16 concentric cable. This is of the high tension lead sheathed type, and is drawn into cast iron pipes; 50 lamps are run in series on this new circuit, and the two circuits which previously existed have been re-arranged, some of the new lamps which have been erected having been added to each of them. Connection is made between the high tension main and

the switches in the base of the post by twin vulcanised bitumen lead sheathed and braided cables, which are drawn into cast-iron pipes, and the lamps are connected alternatively with the outer and inner conductor of the main. Each lamp-post is also provided with a pair of incandescent lamps, and is supplied with an automatic switch which enables the incandescent lamps to be put in circuit from the station when the arcs are switched off. They can also be extinguished from the station by passing the high-tension current through the circuit momentarily in the reversed direction. *Spare Pipes*.—In addition to the pipes laid for the cables, spare pipes have been provided in many places, so that additional cables can be drawn in when required. The total amount of pipes laid on these extensions is 12 miles in length, part of the pipes being 2 inches and part 3 inches in diameter.

Joyner's Switch Lampholder.—A sample of this has been handed to us by Messrs. Chas. Joyner & Co., and we find it an ingenious device. It is designed specially for high voltage, and we understand it is approved by corporations and supply companies. As will be seen by our illustration the side of the holder is removable for wiring, which is extremely easy, the insulation comes right up to



the terminals, and the cord grip screws right down on the porcelain, forming a positive grip on the holder. The contact is on the cam system, but it is in this particular that we think the switch might be improved; mechanically it does not strike us as being so strong as it might be. Improved in that respect it would be most desirable, as the most careless wireman could hardly get at fault in any way.

Messrs. J. Musgrave & Sons.—We understand that in addition to the two engines supplied for the Manchester electricity station, and described in another column of this issue, Messrs. Musgrave have in hand engines for the Southport Corporation, Lowestoft, Bolton, and Hammersmith electricity works. These engines are for electric light and traction work, totalling to about 17,000 I.H.P.

The New Clock at Liverpool Street.—One of the largest electric clocks in the world has just been placed in position at Liverpool Street Station. It is suspended from the central transept of the station, is of Gothic design, and can be readily seen from all parts of the station. The case weighs from two to three tons, is constructed of iron and manganese steel, and forms in itself a room 9 feet square. From the pinnacle to the extreme ornamentation of the base is 21 feet. This clock, according to the *City Press*, will be worked by a regulator clock fixed in the Main Telegraph Office. The latter clock has been specially adjusted, and is kept strictly in accordance with Greenwich time. The electric contact fixed to the new electric clock will be joined into circuit with the other electrical clocks at various parts of the station, and thus an electrical current will be transmitted to all the clocks, the hands of which will move in unison every 15 seconds.

Non-conducting Cement.—Messrs. Lonsdale Bros., Limited, Blackburn, send us particulars of their patent plastic cork non-conducting cement for covering boilers, piping, &c. The object of the composition is to prevent radiation of heat and so economise fuel. It is claimed for this cement that it will show a leak at once at the right spot. If the boilers or piping are covered and varnished over, the varnish will blister at the spot where the leak is situated. Messrs. Lonsdale send us a long list of firms who are using their cement, and among them are the names of many of the leading engineering firms in the kingdom. The borough electrical engineer at Kingston-on-Thames says that it is a good non-conductor and makes a neat and clean finish.

Personal.—Messrs. A. Vandam & Co. have appointed Mr. Edward Ward, late of Ellis & Ward, of Birmingham, as their representative.

The Responsibility of Workmen.—"Fools rush in where angels fear to tread." Though we quote this commonplace saying we must not be understood to hold that it is impossible for a fool to be an angel or an angel a fool. It comes into our head with reference to the performances of certain British workmen which prove abundantly that they are of opinion that they are the special subjects of providence, or else that they think the Workmen's Compensation Act an excellent refuge in time of trouble. We are pretty sure that many a workman has received large sums of money as compensation from an employer when the injured man's carelessness has been the main or only cause of the disaster. The failure to use India-rubber gloves (although ready to hand) when handling live mains is one of many ways in which accidents, fatal and otherwise, have occurred from time to time. But in spite of all that has been said and written in the way of warning, such fatalities and accidents will continue to repeat themselves. One effect of the Workmen's Compensation Act seems to have been to give a greater license to men to rush into danger, or at least to excuse their taking every possible precaution to keep out of harm's way, whereas, previous to the passing of the Act, the chances of compensation were more uncertain unless it could be proved beyond doubt that the master or his machinery were responsible. We are not at all sorry that workmen have been fined at Manchester, upon the prosecution of a factory inspector, for neglecting to use the safeguards provided by employers. A working sawyer has been fined £s. and costs for neglecting to maintain the guard of a circular saw, and an engineer employed by another firm has had to pay 40s. and costs for failing to maintain the fencing of a gas engine. A few such prosecutions will help to bring before the working man the fact that his employer is not the only party to incur liability, and they cannot fail to have a salutary effect upon the general body of workmen who have anything to do with the care of machinery.

Trade Announcements.—The amalgamation of Messrs. Naylor & Holmes, brassfounders and finishers, Keighley, with the Keighley Electric Engineering Company, Limited, is announced. The two businesses will henceforth be carried on under the same management at the Vulcan Brass and Copper Works, by the style and title of the Keighley Electrical Engineering Company, Limited. We are informed that the state of affairs is this: The lease of the Keighley Company on their present premises, Alexander Works, Keighley, being about to expire, they have purchased the Vulcan Works of Messrs. Naylor & Holmes, of Keighley, together with their brassfounding and finishing business which they will amalgamate with their own manufactures, and the Vulcan Works, to which the company is removing, are to be extended and additional plant put down to meet the requirements of rapidly increasing trade. Messrs. Naylor & Holmes have done a considerable business in underground junction box fittings, and this branch will be continued and further developed by the Keighley Electrical Engineering Company, Limited, under the same management as heretofore.

Messrs. The Blake & Knowles Steam Pump Works, Limited, inform us that they have appointed Mr. Philip S. Doherty, of St. James Chambers, 40, South King's Street, Manchester, as their sole agent for Manchester and district.

Wireless Telegraphy.—It is stated that Mr. Marconi has acquired large premises at Chelmsford, where he intends to carry on the manufacture of the instruments in connection with his system of wireless telegraphy. Experiments are also to be carried out at Chelmsford, and for this purpose a huge pole is to be erected, so that messages may be sent from the county town to some point on the Essex coast. It is also stated that steps are being taken to establish a School of Wireless Telegraphy in London. The Board of Trade are, it is added, moving in the matter.

Works Extensions.—Messrs. Johnson & Phillips, of Old Charlton, are having built an extensive addition to their works.

Electric Fittings.—Our representative recently visited the showrooms of Mr. H. W. Calderbank, 78, King Street, Manchester, and found them tastefully fitted up for the display of electrical fittings and glassware. Among the articles exhibited were samples of Messrs. Chas. Joyner & Co.'s manufactures—electroliers, switches, lampholders, and ceiling roses; globes and shades manufactured by A. & R. Cochrane, of Glasgow, the "James" enclosed arc lamp (James & Mills, Pendleton), whose agencies he holds for the Manchester district. We trust his enterprise will reap its due reward.

ELECTRIC LIGHTING NOTES.

Aberdeen.—The mains are to be extended to the Anderson Drive and to Queen's Road West.

Ambleside.—The District Council last week had before it the question of entering into an agreement with the Windermere and District Electricity Supply Company for supplying current in bulk. The Council went into committee to consider the terms, &c.

Asylum Lighting.—At last week's meeting of the governors of the Richmond Asylum it was reported that, with reference to the electric installation at Portrane, in connection with which the governors passed a resolution protesting against the action of the Board of Control in accepting a tender of a Belfast firm in preference to that of a Dublin firm, a letter had been received from the Board of Control stating that the lowest tender was that of Mr. Drennan, of Belfast, at £9,436 17s, but he subsequently withdrew it owing to a rise in the price of materials. The next lowest was that of Messrs. Port, Sykes & Co., Dublin, £9,908 9s. 6d., but this tender was not in accordance with the specification, and could not be considered. The next lowest tender was that of Walsall Electric Company at £10,758, but they withdrew it subsequently. The next lowest tender was that of Messrs. W. Coates, Belfast, at £10,892, and was in strict accordance with the specification. This firm had carried out contracts in various other institutions, and had done the work in a satisfactory manner. The next lowest tender from Dublin, in accordance with the specification, was £942 3s. 6d. above that of the accepted Belfast firm.—Mr. Crozier said that in face of that letter, they could not but feel satisfied with the action of the Board of Control.

Bath.—At a meeting of the Electric Light Committee last week the Works Sub-Committee reported that the excess on extending the station and laying down new plant was estimated at £7,395. Mr. Metzger, the electrical engineer, stated that between £16,000 and £17,000 would be required for the extensions of mains sanctioned by the Council at the last meeting, and various new plant, transformers, &c., and allowing £1,000 for contingencies, they recommended that a further loan of £24,000 be obtained. A resolution was passed that the Urban Sanitary Authority be recommended to apply to the Local Government Board for permission to raise another loan of £24,000 for electric lighting purposes. This will make the total loans for this object between £78,000 and £79,000. With reference to the noise made by the new arc lamps, Mr. Gatehouse sent in a detailed report, which showed that they were still in a very unsatisfactory state. A telegram was received from Mr. R. Hammond, the expert adviser of the committee, stating that the contractors were arranging to reduce the voltage in the lamps, and the company recognised their liability to abolish abnormal noise.

Bermondsey.—At a meeting of the Vestry on Monday, Mr. T. Cox, on behalf of the Electric Lighting Committee, reported that the Bill to confirm the Vestry's provisional order had been read a second time in the House of Commons and ordered to be committed. A petition praying to be heard against the Bill had been presented by the London Electric Supply Corporation. The Committee had therefore decided to retain Mr. R. Littler, Q.C., to conduct the Vestry's case, and had instructed the Vestry clerk to brief Mr. Horace Avory in conjunction with Mr. Littler. It was decided to approve the action of the Committee.

Berwick.—The Town Council has received a letter from Messrs. Edmundsons' Electricity Corporation, offering to light the town by electricity on terms similar to those at Hawick. The Lighting Committee has the matter before it.

Blackpool.—The profits of the Corporation electricity works during the past year were £2,140. The tramways made a net profit of £3,500.

Bradford.—The Corporation Electricity Supply Committee has decided to reduce the charge for electricity for motive power from 2½d. to 1d. per unit to consumers who use it continuously throughout working hours of the day, and from 2½d. to 2d. where it is only in occasional use. The revised scale will come into force in July and remain in operation 12 months.

Bridgend.—The Finance Committee has recommended the Council to accept the offer of the English Industrials, Limited, for taking over the electric lighting provisional order, subject to a satisfactory agreement being arranged. The clerk, in the course of discussion at the Council meeting, said he was advised that they should consider the advisability of advertising for offers for the order in the electrical papers. Eventually the recommendation was referred back to the Finance Committee for them to consider the advisability of advertising, with instructions to report to the next meeting.

Brighton.—The Lighting Committee of the Town Council have presented a report recommending the borrowing of £64,000 for the purposes of the electricity undertaking for 1899 and 1900. The engineer, Mr. Wright, is of opinion that during the current year £26,350 extra capital will be required, and that the needs for 1900 will amount to £37,650. The committee recommend that the money be borrowed for a period of 25 years.

Bristol.—Several main extensions were decided upon by the Electric Light Committee last week. It is stated that the committee resolved upon a new departure in taking continuous current right through the city. The mains will be taken through the central streets so that anyone on the route of the mains will be able to secure a supply of power at a moderate cost. The committee's customers for all purposes have now reached a total of 1,000, and the number of incandescent lamps is close on 70,000, irrespective of street lighting.

Chatham.—Messrs. Barnard's new Theatre Royal, now erecting at High Street, is being fitted throughout for electric lighting by Messrs. B. Young & Co., of Birmingham.

Cove.—The Parish Council has resolved to adopt a waiting policy regarding the electric lighting question, in order to take advantages of the expected electrical developments at Farnborough.

Cowes (I.O.W).—Last week the Council discussed the draft agreement for the transfer of the provisional order to the Edmundson Electricity Corporation.

Dewsbury.—Extensions of the electric lighting works at Batley Carr are contemplated. Since the mains were continued to the Oxford Road district, nearly 1,000 lights have been connected, and there is yet a large number to connect. Instructions have been given to the engineer (Mr. O. M. Jonas) to extend the mains along several thoroughfares. The cost of the extension of the works at Batley Carr will probably be about £10,000, and the work will be pushed on shortly, as the new engine and dynamo will be required for next winter. The tender of Messrs. C. Whitehead & Sons, Ravensthorpe, for the erection of the buildings, has been accepted, the cost being upwards of £2,000. Tenders have been considered for one 110-kilowatt steam dynamo and Willans engine, that of Messrs. Bruce Peebles & Co., Edinburgh, being accepted. Dewsbury has offered to supply current to Heckmondwike at 4d. per unit.

Dover.—At a recent meeting the Council had a further debate on the proposed purchase of the gas and electric light works. A minute recommending that negotiations should be entered into with the Electric Light Company was confirmed.

Dublin.—The new Central Hotel stockrooms have been fitted throughout with electric light. The generating plant comprises two 63-B.H.P. Stockport gas engines driving two Edison and Swan dynamos, each having an output of 150 amperes at 300 volts. The battery consists of 122 Epstein cells with a capacity of 540 ampere-hours. Blackman ventilating fans have been fixed in the engine and accumulator rooms. The whole of the work has been carried out by Messrs. Egan & Tatlow, Dublin.

The Local Government Board has sanctioned the £24,000 loan for electric lighting purposes.

Eccles.—At Monday's Council meeting it was stated that the generating station would speedily be ready for the Corporation to take it over. Delay had been caused by certain sub-contractors.

Edinburgh.—At last week's Council meeting Bailie Mackenzie, convener of the Electric Lighting Committee, made a statement on the progress of the undertaking. He said the demand for electric light in Edinburgh was something phenomenal. Since May 15th last no less than 70,500 8-candle-power lamps had been added to their system. Such a rate of progress had never been experienced in connection with any similar undertaking in the country. He calculated that in the coming year they would have an output for private lighting to the enormous extent of 4½ millions of units, and with 1,200,000 units for public lighting they would have next year the extraordinary output of 5,700,000 units of electric energy. It was expected that they would have a surplus of £14,000 next year.

Exeter.—The Electric Lighting Committee has resolved (and the Council has approved) to add the sum of £100 to the estimated cost of the extension of mains, and to recommend the Council to apply to the Local Government Board for leave to borrow £10,000.

Fulham.—On Wednesday night, at the meeting of the Fulham Vestry, held under the chairmanship of Mr. F. O, Drew, the report of the Lighting, Electric Lighting, and Dust Destructor Committee was considered. The Committee stated that they had very carefully considered the reference to them with regard to the tenders received for the supply of mains, machinery, plant, &c., and a letter from the General Electric Company, Limited, stating that although they had made an error of £1,000 in the sum quoted in their tender for river pipes, yet they were prepared to carry out the whole of the contract in accordance with their original tender, and at the prices set forth therein. They recommended that the lowest draft, viz., the General Electric Company, Limited, for the sum of £45,718 7s. 10d., be accepted for the entire works. Mr. Sayer moved that the report be referred back, remarking that the report of the Committee was cut and dried, and that the electrical adviser of the Vestry was told to attend half-an-hour later so that he might not hear statements made before the Committee. A motion to refer the matter back having been defeated, Mr. Sayer moved that the tender of the British Insulated Wire Company of £14,252 18s. 6d. for laying the mains be accepted. Mr. Medhurst, the electrical adviser of the Vestry, said that in this case kissing had gone by favour, and he emphatically advised that the tender of the General Electric Company should not be accepted. After further discussion, the matter was adjourned till the following Wednesday.

Gorton.—In the provisional electric lighting order just granted to the Council by the Board of Trade, the transfer clause has been allowed to stand.

Hull.—The electrical engineer has presented a report to the Hull City Electric Light Committee on the question of the price of electric light for shops, and the application from the Drapers' Association for a reduction of two-sevenths in respect of the amount of current for which they pay the higher rate—6d. He stated that at the price of 6d. per unit the current had to be used for at least 365 hours in the year before the standing charges incurred by the Corporation (which were determined by the number of lights switched on at once, or the maximum demand) were paid for. If the time limit was to be cut down to 260 hours in the year, or one hour per night for five nights per week, the price of the current would have to be raised to 8½d. per unit, if the additional current used was to be still charged at 3d. per unit, as at present.

Heckmondwike.—The Council on Monday adopted a report by Mr. Hawtayne *re* a scheme for public and private electric lighting, estimated to cost £13,000. A public meeting of ratepayers is to be called. Mr. Hawtayne anticipates a gross revenue of £2,350 per annum, which, if realised, would be sufficient to meet all charges and leave an annual profit of £229. He assumes that at least 6,000 8-C.P. lamps would be required by private consumers, and for public lighting in those parts of the town where cables might be laid for supplying the private demand. The estimated cost of the scheme is set out as follows:—

Buildings	£3,000
Generating plant	5,500
Underground mains	2,310
Public lighting	200
Public arc lamps and pillars with mains, &c.	280
House connections and meters	1,000
Legal and expert services and contingencies	1,000
	£13,290

Ilfracombe.—The Council has decided to keep the electric lighting in its own hands. Mr. Trentham is being asked as to his fees as consulting engineer, if appointed.

Ingleton.—The *London Gazette* contains notice of the intention of the Ingleton Electric Lighting and Power Company to apply for a license under the Electric Lighting Acts.

Kensington and Notting Hill Electric Lighting.—A Committee of the House of Commons has passed the Bill promoted by the Kensington and Knightsbridge Electric Lighting Company and the Notting Hill Electric Lighting Company. By this Bill these companies are jointly and severally empowered to acquire lands and to erect and work generating stations in Hammersmith and St. Mary Abbott's, Kensington.

Lancaster.—Stores and a workshop are to be erected in connection with the electricity works. A small extension of mains is to be made at a cost of £282.

Leamington.—The Town Council has received intimation from the Board of Trade that they are prepared, under certain conditions, to grant them a provisional order for the lighting of the borough. The conditions, which are now under discussion by the Electric Lighting Committee, have, it is understood, reference to the rights of the Midland Electric Lighting Company, which for many years has been supplying light in the borough under an agreement with the Corporation.

Leeds.—The Lighting Committee of the City Council, with a view to popularising the electric light, has now decided to follow the example of the late Yorkshire House-to-House Company, by providing free current to new customers between June 1st and the end of August. To meet growing demands, the depôt in Whitehall Road is to be vastly extended by the demolition of the Britannia Mills, and the site utilised for extension purposes. It is also understood that the Committee intend to apply for leave to borrow £150,000 for carrying out the development of the work which is expected in the near future.

London, E.C.—At the Court of Common Council last week a petition signed by 10,000 citizens was presented, advocating the abolition of the City electric lighting monopoly and the introduction of competition. Mr. Schenk, one of the directors of the Smithfield Electric Lighting Supply Corporation, and Mr. Cooper, the engineer to that company, were among the petitioners who appeared at the Bar of the Court. Mr. Schenk acted as spokesman for the deputation, and, in answer to questions, said the company was prepared to supply the City at 5d. per unit, and 2½d. for motive power. By a new arrangement any accidental extinction of the light would be avoided. He could not say whether the company would be equally content if the Corporation became the suppliers. The petition was referred to the Streets Committee for consideration.

Maidstone.—The Urban District Council has decided to instruct Messrs. Stevens & Barker, local electrical engineers, to draw up an electric light scheme.

Monte Carlo.—On Monday evening the electric light failed here, the big hotels, &c., being plunged into darkness.

Oldham.—A gas explosion occurred in an electric light main box in Yorkshire Street last Saturday.

Pershore.—Mr. Stephens is asking if the Council would object to posts or cables in the event of a scheme of electric light for Fladbury and some adjoining parishes being adopted. The surveyor has the matter in hand.

Peterborough.—The tenders for electrical plant, numbering about 50, were last week referred to Mr. Gill and the consulting electrical engineer, Dr. J. A. Fleming, for tabulation and report. The work is divided into six sections—boilers, engines and dynamos, piping, main laying, switchboard, &c.—and only one firm has tendered for the whole, the aggregate amount being a little over £13,000, whereas Mr. Gill's estimate was about £10,000, which is about the amount of the six lowest sectional tenders. As a matter of fact, there is only £32 difference.

Portsmouth.—Permission has been obtained by the Corporation to add a clause to their Bill giving power to reduce the tramway gauge should it be considered desirable to do so on the system being acquired by the municipal body. The Tramways Committee and the Electric Light Committee are about to enter into negotiations as to the supply of electric current for motive power. No time is to be lost in arranging for the arbitration to determine the sum to be paid by the Corporation for the tramways.

Redditch.—At the District Council last Tuesday the Lighting Committee reported that gas lamps in the district numbering 221 could be supplied with electricity at a cost of £515 per annum.

Ross.—At the general meeting of the parish Council a letter has been read from the legal firm acting on behalf of clients for providing the electric light at Ross. The question was deferred to see what the Urban Council would do in the case.

St. Pancras.—The Electricity Committee of the Vestry have issued their annual account for 1898. The capital expenditure during the year amounts to £32,936 1s. 1d., making the total expenditure up to the close of the year £241,993 16s. 6d. The revenue for the year produced £38,256 0s. 4d., an increase over the previous year of £4,908 0s. 5d., and the net profit for the year amounts to £4,175 2s. 5d., to which is added the balance, £1,717 7s. 2d., brought forward from 1897, leaving a net profit to carry forward of £5,892 9s. 7d.

Shoreditch.—The Vestry, at the meeting on Tuesday, were informed by the Lighting Committee that they had considered reports from Dr. Mansfield Robinson, Vestry clerk, and Mr. Adams, the accountant, in regard to the question of amalgamating the accounts of the electricity and refuse destructor undertakings. As a result, the Committee recommended that from March 25th, 1899, the revenue accounts of the two departments should be combined, that the cost of burning refuse should be debited under No. 1 of Clause A (generation of electricity) in the Board of Trade return as "cost of coal or other fuel," and that the other items of expenditure should be placed under appropriate heads, whilst the receipts from the scavenging and other departments for burning refuse and use of steam should be included under No. 10 on the credit side. The recommendation was adopted, and it was also decided to keep the capital accounts of the two undertakings separate as hitherto, and to pay out of the general rate the debt and interest in respect of the refuse destructor capital. In a further report the Committee recommended and the Vestry decided to order an additional economiser from Messrs. Green & Co., and a feed pump for dealing with 3,000 gallons of water per hour from Messrs. Weir & Co. It was also decided to invite six firms to tender for a pump and filter to deal with the condensed water received from the public baths, and for an outlet pipe and valve to convey water from the artesian well up to the storage tank. The estimated cost of these works was put by the chief engineer at £1,060. It was further resolved to instruct Mr. Newton Russell, chief electrical engineer, to prepare a specification for the erection of two new switchboard panels, and to invite three or four firms to submit tenders for the work.

Sleaford.—A Council recommends the Committee to apply for a provisional order, it having called in an electrical engineer, Mr. B. Smith, of Oswestry, who reports favourably regarding a scheme which will cost £4,600, exclusive of site.

South Shields.—St. Stephen's Church is now lighted electrically. The installation comprises 13 12-light wrought-iron electroliers over the chancel, aisle, and nave. There are separate lights for the organ, porches, and vestries. The work has been carried out by Mr. J. T. Dagleas.

Southampton.—During March the number of units sold was 30,082, showing an increase of 56·7 per cent. over the corresponding month of last year. An equivalent of 728 8-C.P. lamps were connected during the month, and during the first half of April 900 more were connected. Several street lamps are reported by the engineer to have gone out through the joint boxes proving unsatisfactory, and a better type is to be substituted shortly. The Electric Lighting Committee recently considered a letter and report from the Board of Trade on the fatal shock accident, and a reply drawn up by the engineer was duly sent. At last week's Council meeting Alderman Bone proposed the adoption of the estimate of the Electric Lighting Committee's receipts and expenditure, and said there had been an excess of expenditure over receipts amounting to £1,800 for two years, but now they had turned the corner and were making a profit. It had been suggested that they should spread the deficit over five years, so that the ratepayers might get some benefit from the works, and the estimated profit was £182, although he had no doubt it would be very much larger than anticipated.

Stockport.—A storage battery for the electric lighting department has been supplied by the Chloride Electrical Storage Syndicate, Limited.

Stockton.—The sanction of the Local Government Board having been obtained, the manager has been instructed to proceed with the erection of the new electric lighting station on a site adjacent to the gasworks.

Taunton.—The Electricity Committee have reported that they find it necessary to lay down plant at the works at an estimated cost of £2,750, and to provide for other plant and extensions at an estimated cost of £7,250, making a total of £10,000. They therefore recommended the Council to make application to the Local Government Board for their sanction to borrow that amount. At last week's Council meeting the Mayor, in moving the adoption of the report, said that one great advantage of the new condenser would be the effecting of a saving on the coal bill, as compared with that of last year, of £200 at least. The committee felt justified in saying that by expending £2,700 on the purchase of an accumulator, they would save at least £500 a year in working expenses.

Todmorden.—On last week's agenda was a motion for the Council to appoint a committee to consider the desirability or otherwise of erecting electricity works. But as the member who had placed the notice on the paper was absent through illness the matter was allowed to drop.

West Bromwich.—The Electric Lighting Committee have now under consideration two reports on the best methods of lighting the town by electricity, from two consulting engineers.

West Ham.—The following tenders have been received by the Town Council for the supply of engines and alternators:—Brush Electrical Engineering Company, engines and alternators, £17,000; Allen, Son & Co., Bedford, engines, £8,600; D. Adamson and Co, Manchester, £13,900; Fowler & Co., Leeds, £23,148; R. W. Blackwell & Co., engines, £10,706; Fuller Westrom Electrical Company, alternators, £5,480; F. Nell & Co., engines, £12,240; C. A. Parsons & Co., Newcastle, £12,844; Messrs. Ferranti, £15,900; E. Chester & Co., London, engines, £13,000; Beaver, Dorling & Co., engines, £9,980; Hillyers & Co., alternators, £6,800; J H. MacLaren, engines, £11,300; British Schuckert Electrical Company, £18,357; Siemens Bros., £21,320; Thames Ironworks, £21,000; Richardson, Hartlepool, alternators, £8,400. These tenders have been referred to the electrical engineer to report upon to the Electric Lighting Committee.

Weston-super-Mare.—After considering the report of Major Cardew, the Board of Trade has decided not to transfer the Council's provisional order to the local syndicate without the Council's consent. The Council has not yet received intimation from the Board.

Windsor.—The business of the Windsor and Eton Electrical Installation Company is fast growing. A new boiler house is being erected in Peascot Street to hold three new boilers, over which will be a large storage tank capable of holding 10,000 gallons of water. A new engine house is being added for the reception of two steam dynamos of 200 H.P. each, and a third one of 400 H.P., these being in addition to the present plant. There will also be a large heater to utilise the exhaust steam, electrically driven pumps to supply 2,000 gallons of water per hour for boiler feeding purposes, and in place of the present one a new exhaust pipe will be carried up by the side of the chimney shaft. The company are extremely busy installing the electric light at country residences.

The *Times* says that arrangements are being made for the installation of the electric light in the Royal vault beneath the Albert Chapel at Windsor Castle. A branch cable connected with the local electric company's station has been laid through the lower ward to the cloister door of the chapel, under which it passes into the crypt below.

Wolverhampton.—Last Saturday night, about 10 o'clock, there was a failure in the private electric lighting. A Birmingham paper says that two dynamos broke down simultaneously at the works. A second failure occurred on Monday night. Saturday's collapse was due to the simultaneous breakdown of two dynamos, each with a power of 140 kilowatts. On Mr. C. E. C. Shawfield, the borough electrical engineer, being interrogated as to the cause of the breakdown, he stated it was probably due to a weak place in the insulation of the dynamo armature of one of the machines, which allowed the current to escape to earth. That put extra pressure on the other machine, and thus both broke down together. "The machines," said Mr. Shawfield, "were not working at high pressure at the time, in fact, they were carrying well under their usual load. In about three months' time," he added, "we shall have a different system of supply for the town, under which any similar breakdown of machinery will not involve the extinction of the light." Under this new system—known as the three-wire system—no such failure has occurred. It is expected it will be in operation in about three months. A large storage battery is also to be put in, which in the case of a breakdown will be sufficient to keep the lights going till the necessary repairs can be effected. On Saturday evening the lights were out for about 20 minutes. With respect to Monday evening, the first cessation was of 11 minutes' duration, and at the expiration of that time the supply was restored for a few minutes. It, however, failed again, and was in the second instance off for a quarter of an hour. This failure was due to a short circuit on the premises of one of the consumers, and as there were only four transformers running at the time and a comparatively small load on the mains, the momentary excessive current produced by the short circuit threw out the switches controlling these transformers and cut off the supply of current. No damage was done to any of the machines, either at the Town Hall or Commercial Road, and the mishap was not in any way due to anything that occurred at either of these stations. In all probability if the short circuit had occurred a quarter of an hour later when more machines were in circuit no interruption of supply would have taken place.

Worksop.—The Council has passed the following resolution:—"That in view of the great progress being made in respect of the provisional order for electric light and power, the Council should proceed to secure the services of an electrical engineer to prepare a scheme for adoption by the Council, and that the Lighting and Paving Committee be requested to consider the matter and report thereon to the Council."

Worthing.—The Council on Tuesday adopted the electric lighting scheme of Messrs. Burstall & Monkhouse at a cost of £36,900. Application is to be made to the Local Government Board *re* loan.

York.—The City Council proposes to appoint a resident electrical engineer at £200 a year. The machinery is approaching completion. The Council is entering into a free-wiring agreement with Messrs. Porte, Sykes & Co.

ELECTRIC TRACTION AND MOTIVE POWER NOTES.

Baker Street and Waterloo Railway.—At the resumed sitting of the Parliamentary Committee last week, Mr. Jeffreys, the chairman, stated that the committee had decided not to grant the application of Mr. A. Tatham for a protective clause, but they would grant a clause to the Gordon Hotels Company in respect to the Grand Hotel. They had further agreed to extend the period for the authorised line for two years so far as regarded the acquisition of lands, and for four years in regard to the construction of the works, both periods to date from March 28th last.

Darlington-Stockton.—The Works Committee report to the Durham County Council contains the following:—"The Imperial Tramways Company has applied for leave to lay an electric cable from Stockton along the main road to Darlington for the purpose of supplying power to a light railway they propose to construct in and near the last-mentioned place. The county surveyor informs us that there is already a large water main 2 or 3 feet in diameter under nearly the whole length of the road, and that in his opinion it is not desirable to weaken the road further by allowing the proposed cable to be also laid under it, and we therefore cannot recommend the Council to accede to the application." The Council adopted this report by the casting vote of the chairman.

Darwen.—The Corporation having recently purchased their tramways, are now about to convert them from steam to electric traction, and, as a preliminary, formed their Tramways Committee on Monday last week. Mr. Alderman Lightbown was elected chairman, and Mr. Councillor J. W. Gillibrand vice-chairman. The Committee instructed the borough surveyor (Mr. Smith-Saville) and the borough electrical engineer (Mr. Stanley Clegg), who are now carrying out an electricity supply scheme for the borough, to proceed with the details of work necessary for the conversion, with a view to letting the contracts at the earliest possible date.

Dover.—Lieut.-Col. Yorke held an inquiry last week regarding the Council's application to borrow £7,350 for tramway purposes. The town clerk said that the £31,000 already sanctioned for the tramways being insufficient, the sum above mentioned was required for additional cars, workshops, signals, and doubling the line. The additional cars were needed owing to the great increase of traffic beyond what was expected. In the year ended March 31st the cars carried 2,176,000 passengers, earning £9,044 in pennies. The profit, after paying interest on the loan and one-thirtieth part of the capital, amounted to a sum approaching £2,000. This unexpected traffic rendered 16 cars necessary, whereas they only estimated for eight and two trailers that had been turned into cars. The town clerk said that the borough rates had been reduced from 8d. to 6½d., mainly owing to the tramway profits. The surveyor gave details of the sum of £7,350 to be borrowed, namely, seven new cars at £560 each, £2,920; converting two trailers into motor cars, £600; new workshop, £760; signalling apparatus, £240; additions to car sheds, £378; converting single into double line, Cannon Street to Biggin Street, £1,350; other expenses, £102. In reply to the inspector, the surveyor said that they had had no serious accidents with the trams. The lifeguards in front had in one case picked up a boy without injuring him. The inspector said he asked the question because there were several lifeguards in use, and he wanted to find out which was the most effective.

Eastbourne.—The Council on Monday had the tramway question before it, and it was decided to hold a special meeting on 25th inst., to determine upon the expediency of applying to the Light Railway Commissioners for an order.

Electric Locomotives and Tramcars in Italy.—Mr. F. Armstrong, the British Consul at Milan, reporting on the trade of Lombardy in 1898, draws attention to the great importance of the Italian market for electric plant, and reminds British manufacturers that an international exhibition of electricity in all its applications is to be held at Como from May to September this year, to celebrate the centenary of Volta's discovery of the galvanic pile. He states that the Government contemplates the eventuality of requiring, at no very distant period, water-power for the purpose of applying electric traction to the railways, which are nearly all State property, although actually leased to companies. The Mediterranean, one of the largest Italian railway companies, has quite recently commenced an experiment of electric traction by means of accumulators on its line between Milan and Monza, a distance of 8 miles. The time occupied in the journey is, including stoppages, 20 minutes. The speed obtainable is about 25 miles an hour, and the accumulators can do about 43 miles on level ground, without having to be recharged. The Edison Company supplies 60 kilowatts at 3,600 volts, which are transformed at the Milan railway station into 500 volts. For this force, which is equal to about 80 horse-power, the railway company pays £920 a year. Electric traction has now been applied to all the city lines of tramway in Milan. The total number of tickets issued last year was 44,559,888, as against 39,736,091 in 1897, and the share of the municipality in the net profits amounted to £36,000 in 1898, as compared

with £38,000 in 1897. Judging from the yield of the first two months of the year, it seems likely that the profit for 1899 will reach at least £40,000. From 7 to 9 a.m. the fare on all the lines has now been reduced to 5 c. (½d.) for the benefit of the working classes. This concession does not result in any loss, for it is found that the number of passengers during those two hours is three times what it was formerly.

Hamilton.—At a special Council meeting last week it was remitted to a committee to approach the local authorities interested to consider the expediency or otherwise of promoting a scheme of electric or other traction in connection with the more populous districts of the Middle Ward.

Ilford.—Upon Mr. Hawtayne's recommendation the Council is sending a deputation to inspect electric trams at Glasgow and other large towns.

Italy.—La Societa delle Strade Ferrate Meridionali is reported to be preparing plans for a plant to utilise the water-power of the Brembo by means of a derivation canal from Ponte della Ca to Ponte di Sedrina, where it is said no less than 7,000 H.P. would be available. The electrical energy generated is intended to be employed for traction purposes on the Bergamo-Lecco, Bergamo-Seregno, Bergamo-Milan and Bergamo-Breslio railways.

Limerick.—The Limerick Electric Tramways Company has lodged particulars with the town clerk for the construction of electric trams.

Lowestoft.—The Mutford and Lothingland Rural District Council last week approved the scheme for the proposed Lowestoft and District Electric Railway, which would pass through their district.

Newcastle.—The New Tramways Committee recommends the appointment of a resident electrical engineer. This proposal follows the recent decision to at once engage the services of an electrical engineer to advise in connection with the overhead system of electric traction for the new tramways.

Peterborough.—The British Electric Traction Company, it is said, are prepared to spend £70,000 on the proposed electric tramways for Peterborough. All the necessary preliminary arrangements have been made, and the customary legal and statutory notices, with the plans, &c, will be deposited with the Corporation in about three weeks' time, when the official notices will be published.

Plymouth.—The Tramways Committee the other day had under consideration the electrical engineer's plans and estimates for the use of electric traction on the Hyde Park and Compton routes, and decided to recommend the Council at its approaching meeting to approve of the scheme and to sanction its early application. The estimated cost is said to be something like £18,000, and it is calculated that even on the basis of the present traffic the use of electricity will effect a very considerable saving of expenditure. Whilst the electrical station at Prince Rock is in a fairly forward state, the completion of the installation is delayed by the erection of the chimney.

South Staffordshire.—The British Electric Traction Company gives notice in the *London Gazette* that it intends making formal application to the Light Railway Commissioners for additional provisions in the South Staffordshire Light Railways order for certain railways in the district of Willenhall.

Spen Valley.—It is stated that the Cleckheaton District Council have made a determined move against the scheme which the British Electric Traction Company have suggested for linking the Spen Valley with the Dewsbury district by means of electric trams. The objections rest mainly upon the fact that the scheme is being promoted under the Light Railways Act, which, should the application for an order succeed, would give the promoters an exclusive monopoly for 35 years, and even then, if the local authority desired to purchase the undertaking, it could only be on the basis of "fair market value," which would, of course, include goodwill. If the application were under the Tramways Act, the order would give the option of purchase at the expiration of a comparatively short term, on the basis of the value of the plant only. The Council have, accordingly, lodged various objections with the Light Railway Commissioners. The Dewsbury Corporation have given notice of opposing the scheme, but probably their opposition would have dropped if the company had undertaken to take their current from the Corporation. Heckmondwike has decided to oppose the scheme, but will withdraw their opposition if certain concessions asked for are made. It is understood also that the Liversedge District Council will oppose on points of detail.

Worcester.—Last Saturday Messrs. Garcke & Lycett (British Electric Traction Company), and representatives of the Worcester Tramways Company, inspected proposed routes for light railways. It is said that the promoters, whose proposals are to be shortly laid before the Council, will be prepared to consider an offer of a supply of current from the Council for working the cars.

TELEGRAPH AND TELEPHONE NOTES.

The British Pacific Cable.—Following the announcement which appeared in the *Times* of the 27th ult. regarding the agreement reported to have been come to on this subject, Mr. Hogan, M.P., asked "the Secretary for the Colonies whether Her Majesty's Government had now arrived at an agreement with the Governments of Australasia and Canada in the matter of the construction of the Pacific cable." In reply, Mr. Chamberlain said: "Her Majesty's Government have made a proposal to the Governments of Canada and Australasia, but no final agreement has been made. The statements on this subject which have appeared in the Press do not accurately represent the proposals which have been made."

On the same day the Duke of Devonshire, addressing the British Empire League at Eastbourne, said, doubtless in reference to the meeting of the Council of the League held on March 6th: "Another subject discussed, upon which a resolution was not passed (believing as they did that the subject was not ripe for the passing of a resolution), was that most important one, the establishment of the Pacific cable connecting our Australian colonies with the Dominion of Canada, and thereby establishing telegraphic communication between ourselves and our Australian colonies, and passing entirely through British dominions."

On Monday last Mr. R. G. Webster M.P., asked "the Chancellor of the Exchequer whether a decision had been arrived at in the matter of the Pacific cable scheme; and whether Her Majesty's Government had decided to contribute, in the form of a yearly subsidy, the full amount which they have been recommended, under the Report of the Pacific Cable Committee of 1896, to guarantee for the construction of an all-British cable running from Vancouver by Fanning Island to Norfolk Island, whence it will branch to Queensland and New Zealand; and if so, whether he could give the House any further information on this subject." The Chancellor of the Exchequer said in reply: "A decision has been arrived at. Papers will be laid on the table at once explaining the terms on which Her Majesty's Government has offered to contribute."

As further information is shortly to be given in the House of Commons, we prefer to make no comment at present. The Canadian Press gives vent to very strong opinions on the subject, and we read that in Canada "the feeling of disappointment at the refusal of the British Government to co-operate as part owner of the proposed all-British Pacific cable is growing. The basis of partnership was the one upon which all the negotiations were conducted, not that of a subsidy."

The *Montreal Witness* refers to the Government's decision as poor encouragement to Imperial Federationists, and says its change of policy is due to the influence of the Eastern Telegraph monopoly.

The Dominion Government has been advised by cable that the Imperial authorities will only give a subsidy to, and not take any stock or share in, the Pacific cable scheme, and that the subsidy will not exceed £20,000 annually.

The *Evening Journal* says this virtually means that there is no prospect of going on with the project, and very little chance of it being realised in the future.

In the English Press also some strong remarks are made, some of them, in our opinion, without any justification; but we hope that soon the matter will be more clearly understood.

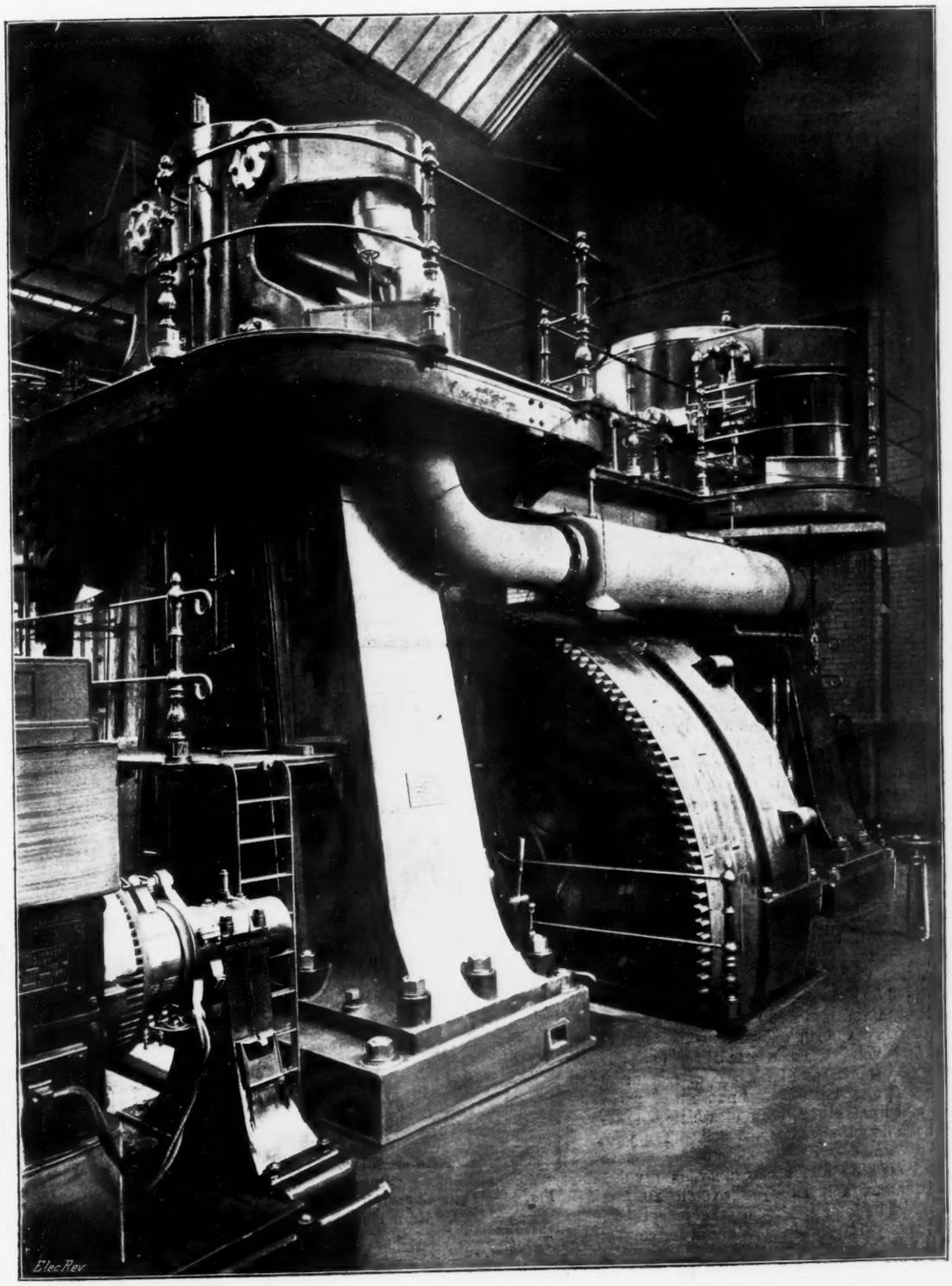
The Cape to Cairo Telegraph Line.—In the speech of the Right Hon. Cecil Rhodes to the shareholders of the Chartered Company on Tuesday last, Mr. Rhodes made the following reference to the trans-Continental landline, by means of which he hopes shortly to effect a reduction in the present high rates for cablegrams to the Cape:—"Now I think you would like to hear a few words from me about our development, and we have been most successful really in so far as our development by telegraph goes. I think that every small town and village possesses a telegraph, and in connection with that project which I am personally interested in—namely, the extension of the telegraph through Africa—I think you would like to learn that it is proceeding with the greatest success. I may mention this because, in one way, you are practically interested, though not beyond your own territory, because we must deal with all the undertakings connected with your country, and not plunge you into any scheme outside your area. But it happens that this project of the trans-Continental telegraph passes through your territory, and you have taken an interest in that telegraph simply to the limits of your State. Beyond that, naturally, you should not invest, but it gives you a certain interest in that line. You will be glad to learn that when I proceeded the other day to Egypt I was able to settle in connection with that line a reasonable rate. What I felt was, that if I waited until our line reached the Egyptian boundary—I will not say that they would blackmail us, but I have found that my own countrymen are peculiarly good at a bargain, especially if you find that they are the sole people to be dealt with. I therefore thought that it was wise, long before we reached the Egyptian boundary, that I should find out what they would charge us, and I think a fair and reasonable settlement has been made. They agreed to charge me 2½d. a word, which I think will give them a very handsome return, because it will be an extra amount of revenue accruing to their telegraph fund, which they would not otherwise receive. Still, I think that we can fairly pay that, when you remember that the charge for telegraph correspondence from Africa is represented by the sum of 5s. a word."

The Telephone Question.—Mr. Hanbury, M.P., on Wednesday received a deputation from chambers of commerce and other bodies, who asked the Government to purchase the undertaking of the National Telephone Company and work it as a department of the Post Office. Mr. Hanbury, in reply, said the really national part of the service was in the hands of the Government already, and he urged various reasons why it was better that the local service should be put in the hands of the local authorities. What the Government were doing was a gradual step in the direction of nationalisation if practice and experience should prove that it was necessary. In the meantime the Government would do their best to see that the present subscribers did not suffer, and they would endeavour to cheapen the telephone service.

(*Continued on page* 733.)

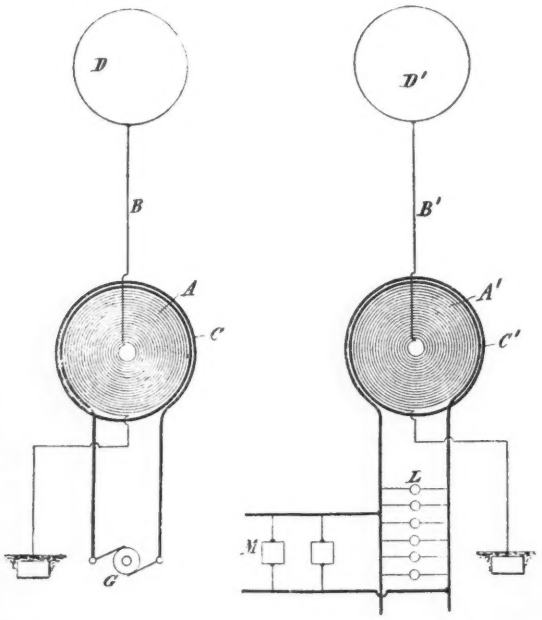
A LARGE UNIT AT MANCHESTER.

Even in these days of large units a description of the plant which has been recently erected at the Manchester Corporation electricity works is of interest. Through the courtesy of Mr. Wordingham we have been enabled to photograph the plant, though, pictorially speaking, the exigencies of space prevent us doing credit to this striking piece of work.



The engine has been made by Messrs. John Musgrave and Sons, Limited, and is of the vertical cross compound type, having cylinders 38 inches and 72 inches diameter, 3 feet 6 inches stroke. The engine is made to run at 100 revolutions per minute, and suitable for a boiler pressure of 120 lbs. per square inch. Both cylinders are jacketed both in body and covers, and have double ported Corliss valves, actuated by eccentrics from the crankshaft, and Musgrave's patent automatic trip gear, coupled direct to the governor, which admits the steam to the high-pressure cylinder at 2 or 3 lbs. less

pressure than the boiler pressure. Two stop valves are coupled to the cylinders from the duplicate main range. The normal load of the engine is 2,500 I.H.P., but it is capable



Tesla's High Potential and High Frequency Work.—Fig. 1.

of giving out fully 25 per cent. above this load. A heavy fly-wheel is keyed to the crankshaft, and the wheel boss is also prepared to fasten to the dynamo. The sides of the engine are entirely enclosed, and forced lubrication is adopted. Two ram pumps are fixed on this engine for this purpose, and pump the oil under pressure (which can be regulated at will) to the main bearings under and over, also to the crank pins, cross-head pins and slide blocks. A gauge is fixed in the pipes showing the pressure of oil supplied. The engines are very massive in appearance, and work noiselessly, and no vibration is discernible. The moving parts of the engines are balanced in the cranks. White anti-friction metal is used in all the bearings. The engine is also supplied with a large platform surrounding both cylinders, and an intermediate platform to enable the attendant to get at the cross-head, slides, and indicating apparatus.

The engine is made to work condensing and non-condensing, the condenser being on Korting's principle, and is supplied by water from a large tank over the boiler house.

The generator has been made by the Electric Construction Company, Limited. The normal output is 3,500 amperes at 410 volts, the range of voltage extending to 430 with 4,750 amperes as an emergency load, or with normal output up to 500 volts when required for tramway work. The somewhat high speed of revolution had the effect of limiting the number of poles, which was fixed at 12, each of which is energised by a double-coned shunt coil. The yoke frame, on account of its magnitude, and to facilitate erection and accessibility, is divided into six parts, and measures overall 20 feet 6 inches. The total weight of the machine is, approximately 120 tons. The armature core is carried by a balanced centre, provided with a double set of arms of oval section. The armature is tunnel wound, and the coils are formed in one piece, *i.e.*, without joint between one commutator segment and another, the commutator itself being 9 feet 10 inches in diameter. The brush gear includes an endless rack operated by worm gear and double hand wheels, so that when standing on the brush platform the attendant may replace old brushes by having the whole of the brush holders successively rotated past him. The current is taken off to the main terminals from the circular positive and negative brush bus bars by special terminal brushes, the current being too large to permit the use of flexible leads. Notwithstanding the magnitude of the machine, the number of parts involved and the difficulty of erection, it was started under load without incident, and was at once put on to Corporation supply mains, and has been in use almost daily from the end of December until recently, when the exigencies of the load no longer demanded it. The electrical efficiency of the set is over 98 per cent. The commercial efficiency has not yet been determined, owing to the machine having been required for service.

TESLA'S HIGH POTENTIAL AND HIGH FREQUENCY WORK.

Few inventors, in this last decade of a century of invention, have made a greater impression on the popular imagination than Nikola Tesla. Though by race a Southern Slav, he has now been settled for many years in the United States of America. From his race, it is to be presumed, he inherits his soaring scientific imagination, while from his environment he no doubt receives an extra stimulus to carry his fancies into practical effect.

Tesla, in the early part of his career, did some good work in connection with polyphase currents, but some 10 years ago he turned his attention to a comparatively new and unexplored field, namely, the production and utilisation of alternating currents of high frequency and high potential. Tesla's labours in this field have up to date revealed many new and startling phenomena, which, though they have as yet not found much practical application, may yet lead to the most astounding social and industrial revolutions.

A letter from Tesla, giving a sketch of his work and describing some recent experiments, appears in the *Electrical Review* (N.Y.), March 29th, 1899. From this and other sources we have derived the material for the following account of Tesla's investigations on the production of currents of extremely high potential:—

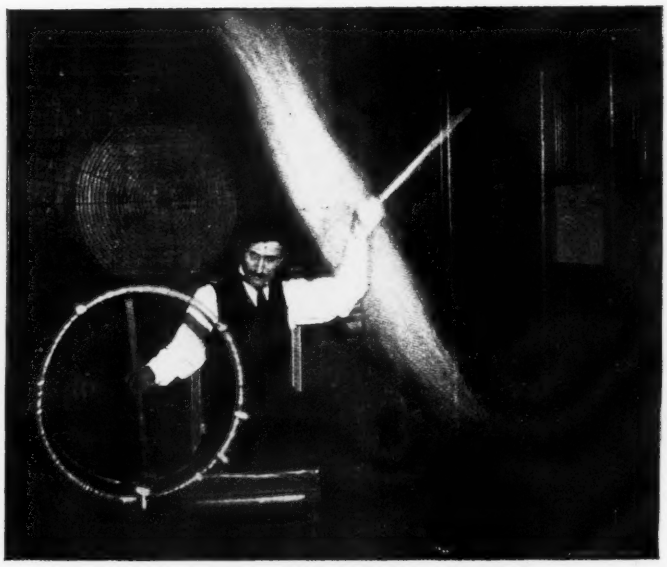


Fig. 4.—"Some Experiments in Tesla's Laboratory with Currents of High Potential and High Frequency."

The operator's body, in this experiment, is charged to a high potential by means of a coil responsive to the waves transmitted to it from a distant oscillator, and a long glass tube waved in the hand is lighted to great brilliancy by the electrical charges conveyed to it through the body.

At the beginning of his work Tesla found himself con-

fronted by three attractive lines of investigation; "there were the excessive electrical pressures of millions of volts, which opened up wonderful possibilities, if producible, in practical ways; there were the currents of many hundreds of thousands of amperes which appealed to the imagination by their astonishing effects; and, most interesting and inviting of all, there were the powerful electrical vibrations with their mysterious actions at a distance."

The production of high electrical pressures was finally chosen as, necessarily, the first step in the exploration of the whole field. Some attention was given to static electricity with the experiments of Franklin as a starting point. Various generators of static electricity were tried, and some new ones were designed. Tesla has not as yet published any account of these static generators which he has designed; it is to be hoped he will do so soon. The most valuable outcome of these experiments was the discovery of a method of operating any kind of low tension devices from such high pressure sources with perfect ease and safety.

Tesla, however, soon convinced himself that his object was not to be attained by the use of the steady pressures produced by static machines. "It was exactly," he says, "as if one attempted to drive piles into the ground by the application of continuous pressure. This would require cumbersome and powerful machinery, and would be very inconvenient. An incomparably better way of developing high pressure is by delivering violent blows as with a hammer." The kinetic energy of a hammer, when suddenly arrested, develops very high pressures, proportional to the rigidity of the body struck. In the same way, reasoned Tesla, enormously high potentials will be developed in the most convenient way by the electro-magnetic energy of a suddenly arrested current. This turned Tesla's attention to the use of transformers and induction coils for obtaining his high pressures. Those already in existence were evidently not adequate for the end in view, so Tesla set about improving them. First he tried the closed core transformer. This type was soon found to have several drawbacks; the insulation could not be made very high, and a very high frequency was impossible. Nevertheless, an arrangement of several of these transformers in series was devised, by which a pressure of 200,000 volts was attained. The secondary coils of several ring transformers were connected in series, while the primaries of all, except the first, were excited by insulated dynamos. This, however, was found to be practically a very inconvenient arrangement.

The straight open core type was then tried; several improvements in the insulation and arrangement of coils were tried, which appear to have been much the same as what has long been known to the makers of induction coils, such as winding in compartments, making the insulation thicker where a greater D.P. existed between adjacent parts of the coil, and so on. The first real advance made by Tesla appears to be his coil with a unipolar secondary. One terminal of the secondary wire is connected to the primary, the free terminal, as far distant as possible from the primary, being used for the discharge. A curious discovery made by Tesla in connection with this type of coil, was that the best results were got when the secondary wire was equal to a quarter of the wave length, as calculated from the frequency and velocity of light. This discovery Tesla has utilised in his most recent induction apparatus, with which he proposes to transmit electric currents through the air. It is difficult to explain this result; it appears as if something of the nature of a stationary wave of potential, with anode at the earthed terminal, was generated in the secondary wire.

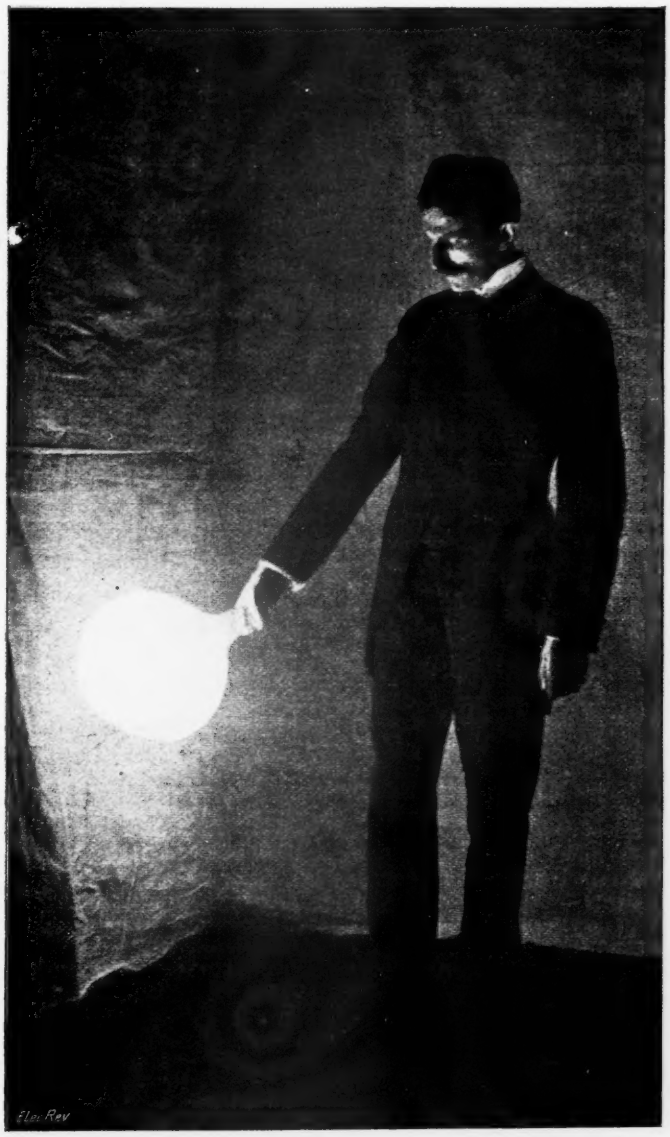


Fig. 2.—"Some Experiments in Tesla's Laboratory with Currents of High Potential and High Frequency."

Lighting a disconnected vacuum bulb of 1,500 C.P. by high-frequency currents—photograph taken by the light of the bulb itself, exposure about two seconds.

During these experiments Tesla discovered that air played an important part in the breaking down of insulation, and by the exclusion of air, and the use of insulating liquids, he was able to increase the potential to 10 times the amount, without breaking down the insulation of the secondary. Tesla complains that the industrial world does not appear to have profited by the recognition of this discovery, since no attempt has been made to utilise it in cables for high potential transmission, to prevent streamers. It is a fact that the liquid insulation is less in favour in practice than when attention was first called to it by Tesla's experiments. It appears to have many practical inconveniences, and it is doubtful whether it is really superior to the solid insulation except for the high frequencies employed in the Tesla apparatus. An induction coil with viscous insulation was brought out a short time ago by Rochefort and Wydts,* and was said to be

* Electrical Review, 42, p. 165.

a great advance in efficiency, but it, like all the rest of such apparatus, has apparently dropped into disuse.

The final result of Tesla experiments with high tension generators was the coil or transformer illustrated in adjacent figure. In this coil the secondary coil is wound in a spiral lying practically in one plane perpendicular to its axis; its external terminal is earthed, and its length is made equal to a quarter wave length. The primary consists of a few turns of thick wire wound outside the secondary, lying thus adjacent to the part of the secondary whose potential is zero. It is with this apparatus that Tesla has made his experiments in the transmission of power through the atmosphere. The figure shows two transformers, a transmitter, and a receiver. The central terminals are connected to elevated plates, D, D', which require to be supported at a considerable height on a kite or a balloon. Tesla thinks a such a calamity and yet go on with his experiments? Evidently the Tesla transformer is what Sir William Crookes wants to increase our supply of nitrates, and keep the wheat crop up to the demands of the world's increasing population; it is to be hoped Tesla's experiments will not solve the food problem in another way by reducing the population to zero.

The large size illustrations we publish show some remarkable results obtained in Tesla's laboratory by this coil. Fig. 2 shows a vacuum tube giving 1,500 C.P. illuminated by electric waves from a Tesla oscillator. Fig. 3 is a photograph showing a part of the laboratory with a disconnected resonating coil supported on an insulating stand, and illuminated by the streamers produced, other coils remaining unaffected. The pressure developed in the resonating coil is over half a million volts. In a similar experiment

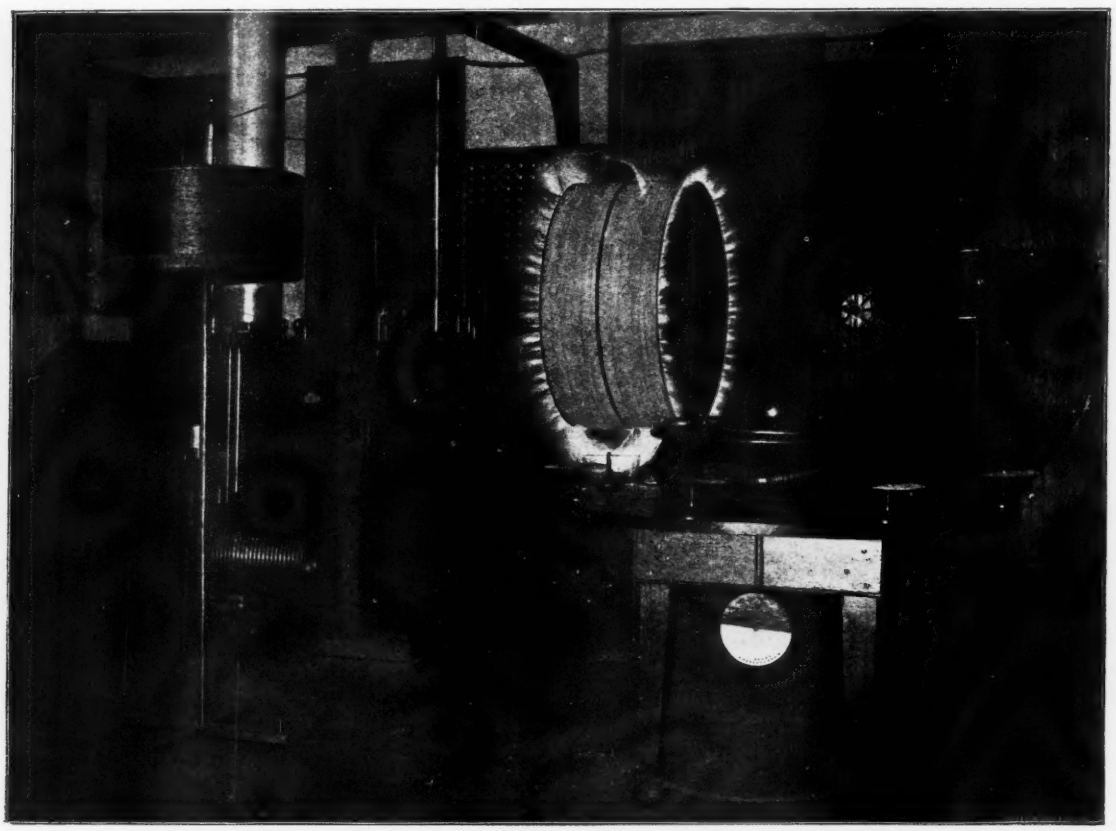


Fig. 3.—"Some Experiments in Tesla's Laboratory with Currents of High Potential and High Frequency."

Photograph showing a part of the laboratory, with a disconnected resonating coil supported on an insulating stand, and illuminated by the streamers produced, other coils remaining unaffected—the pressure developed in the resonating coil is over half a million volts.

height of four miles will be sufficient. The air at such a height is supposed to break down under the enormous potentials developed, and become dissociated into a good conductor. This system of Tesla's has yet only appeared on paper, or, at least, no experiments on a large scale have been carried out in public. The criticisms with which this scheme was received when announced last November were by no means favourable. But Tesla is a pioneer in this field, and probably knows more about it than his critics. It is to be hoped that we shall soon see such a practical trial of his system as will finally determine its true value.

Tesla hints at a fearful catastrophe which might result from the introduction of his system of wireless transmission of power. The discharges of his coil when of an electromotive force of a few million volts, excite powerful affinities in the atmospheric nitrogen, causing it to combine readily with the oxygen and other elements, particularly in the presence of aqueous vapour. So energetic are these actions, and so strangely do such powerful discharges behave, that, says Tesla, "I have often experienced a fear that the atmosphere might be ignited." Can Tesla seriously believe in the possibility of Tesla grasped, without danger, a nodal point in a coil developing half a million volts. Fig. 4 shows a receiving coil illuminating a vacuum tube through the human body.

Very few details of the construction and operation of these latest fruits of Tesla's inventive genius have yet been published. For instance, we are left in the dark as to whether Tesla excites his high tension transformer by an alternating dynamo, or by a continuous current and a contact breaker. It is evident that lately he has been giving considerable attention to the latter device, in connection with an induction coil which has been exhibited in this country, and is generally known as Tesla's oscillator.

In 1891 Tesla patented a method of producing high frequency and high potential currents, in which an alternating generator sends currents through a primary, the secondary of which is in circuit with a condenser. This condenser lies also in a shunt circuit containing the primary of a second coil and a spark gap. The discharge of the condenser across this spark gap produces high frequency oscillations in the shunt circuit, and these oscillations are raised to an exceedingly high potential in a secondary coil wound round the

second primary. It was with an arrangement such as this that Tesla obtained the marvellous results which he showed before the Institution of Electrical Engineers at the Royal Institution in 1892. The discharge from his apparatus appear to penetrate with ease the best insulators; electrodeless vacuum tubes were illuminated at a distance of several yards from the poles of his coil; unipolar lamps gave out a light of dazzling whiteness, but unfortunately of very small candle-power. It appears to be one of these unipolar lamps that is held in Tesla's hand in fig. 2. If so, very considerable progress has been made since the Royal Institution lecture in 1892.

It is a coil of the above type that is generally used for producing Tesla currents for electro-medical purposes. Their use for certain purposes in electro-therapeutics is said to have been highly successful. It is a curious fact that such discharges of a potential of tens of thousands of volts can be passed through the body without any injury. A satisfactory explanation of this strange phenomenon has not yet been given; it has been suggested that it is because these rapidly varying currents must be purely superficial; it may, perhaps, be due to the fact that such currents are almost completely wattless, owing to the displacement of phase between the current and the electromotive force being almost a maximum.

In 1896 Tesla patented an improved generator of high frequency currents, which is known in this country, at least, as Tesla's oscillator. The spark gap in his first type of generator was replaced by a mechanical contact breaker, and the arrangement of the circuits was somewhat different. A condenser is connected in shunt in a circuit containing a continuous current generator, choking coils, the primary of the coil, and a contact breaker. When the circuit is closed by the contact breaker a direct current flows through the circuit. The circuit is then suddenly broken, and the condenser is charged to a very high potential by the self-induction of the choking coils. The contact breaker again closes the circuit, and the condenser discharges through the primary, which, being of few turns, has a comparatively small self-induction. The result is, that the frequency is considerably higher than in the ordinary induction coil where the choking coils would form part of the primary coil. This oscillator has been shown more than once in this country; it can be worked from lighting mains, and its working appears to be highly satisfactory.

It is apparently in connection with this oscillator that Tesla has devoted himself to the improvement of the mechanical contact breaker. In his original patent for the oscillator (No. 20,981, A.D. 1896) he describes a rotary contact breaker, which creates by its motion a current of air about the contact points, with the view apparently of removing the dissociated air, and improving the insulation of the spark gap. It is in a more recent patent (No. 12,866, A.D. 1898) on electric circuit controllers that we find embodied Tesla's latest discoveries in this field. The contact breakers there described are mechanical, of a very elaborate construction; too elaborate, we should think, for general use with induction coils, unless their superiority to the present simpler forms is very great. Two new ideas appear to be embodied in these interrupters; first, the break takes place in compressed air or other suitable gas, and second, a jet of mercury discharged against a metal plate, or another jet of mercury is used to complete the circuit. The metal plate is rotated by an electro-motor, and is notched on the periphery where the jet of mercury impinges, so that contact is broken when the jet passes through one of the notches between the teeth. Tesla has expressed a somewhat ungenerous contempt for the Wehnelt break, which has recently given such remarkable results in the hands of experimenters here and abroad. Its inferiority to Tesla's break appears to be known as yet only to Tesla; in simplicity, at least, it is certainly superior.

We, however, wish Tesla success in the working out of his grandly conceived, and if realised in practice, undoubtedly epoch-making ideas.

The Royal Society.—Among the papers down for reading yesterday afternoon was one by Mr. A. E. Tutton, "The Thermal Expansion of Pure Nickel and Cobalt."

TELEGRAPH AND TELEPHONE NOTES.

(*Continued from page* 728.)

Glasgow Telephones.—The Glasgow Chamber of Commerce last week considered the Government Telephone Bill. The chairman said that the Bill which Mr. Hanbury had introduced had disappointed those who desired to see the telephones of the country handled by a department of the Civil Service, Post Office, or otherwise. This Bill was in some measure a retrograde step. It seemed that the Treasury desired not to go through with the matter at the present time, or it might be that the Bill might lead pretty directly to what they desired, because the very production of this measure had lowered the value of the National Telephone Company's shares so much that it was a very much easier thing for the Government to buy up the Telephone Company than it was three months ago. If there had been no such thing as a National Telephone Company in existence, he quite believed that the great Corporations might have gone into this business and done it very well. It was arranged to send a deputation to Mr. Hanbury on Wednesday.

Glasgow Corporation Sub-Committee on the Opening of Streets has decided to appeal to the Railway Commissioners against Sheriff Berry's decision that the Postmaster-General is entitled to lay wires under the public streets, and that the municipality cannot attach the condition that they shall not be allotted to a licensee. The appeal will probably be heard by the Commissioners along with a somewhat similar appeal taken by the Corporation of Edinburgh.

International Complications in British Telegraph Offices in the Far East.—The following correspondence has recently appeared in the *Times* (previous to the semi-official announcement regarding the Pacific cable agreement):—

Sir,—Mr. Hanbury's courage in grappling with the telephone difficulty is of happy augury for the Government's action in a kindred department—that which has to deal with the Imperial cable question. In that problem, too, a similar solution is obviously demanded, namely, State ownership and State exploitation. No half-and-half arrangement of subsidy and partial control will be satisfactory for two reasons—it will be more expensive and the control will prove illusory and inefficient. Owing to the conditions surrounding cable work it is exceedingly difficult to exercise sufficiently close supervision on "the man in possession"; indeed, everything points to the necessity for tightening the grip of the State in this direction, and it is to be hoped that the Government will not seek to make a devolution of its Imperial responsibilities upon any company or corporation whatsoever.

Rumour has been busy with this subject lately, and it is confidently affirmed in certain quarters that the working of the projected all-British cables is about to be entrusted to the companies known as the Pender group. The supposed inertia of officialdom—an idea which has been somewhat rudely dispelled by Mr. Hanbury—gave an air of probability to the rumour. It is true that the course foreshadowed would save the Government a world of trouble, but there are considerations which do most effectually put that group out of court. This is not the place to enter on a review of their treatment of the public and the Press—that is another story; I refer to a matter of more importance than either.

Some years ago the Pender group effected an amalgamation of office, in Hong Kong with the Great Norhern Telegraph Company of Copenhagen, whose cable connects with the Russian Government Telegraph Administration. It would seem that the Danish company handed over its rights in that agreement to Russia, inasmuch as the company's representative in London declared in an interview some months ago that the cable worked from the joint office and introduced as a Danish cable is now Russian property. Consequently the Pender group are responsible for the existence of this dangerous anomaly—that Russian officials are admitted to an important telegraph office in an outpost of the empire, through which all telegraphic communications with our Government, public, and Press must necessarily pass! There, at any rate, the door is wide open. It will not do for the Pender group to plead ignorance of the intimate relations existing between the Danish company and the Russian Government; that was a matter of common knowledge in China long before the amalgamation.

But apart from considerations of public safety, it may well be doubted whether any great cable service should be left to the mercy of City vicissitudes and the ebb and flow of City morality. There is a period in the history of many companies when the Board know nothing, and the wirepullers' respect nothing. The public have never realised what golden opportunities a cable service presents to the latter; they can favour certain clients at the expense of others: they can run rivalry with clients in their legitimate business, and they can appropriate the clients' property. We do not suppose that cable companies differ greatly from others as regards their management, but this we do know, that no other conditions offer such temptations, nor render detection so difficult.

These being some of the abuses to which telegraph services are liable, it will be seen that there are weighty arguments in favour of State ownership and State exploitation.

The colonies, I understand, are ready to provide five-ninths of the subsidy for the projected cables. To the Government I say, with all respect, "Do not put our money on the wrong horse."

Your obedient servant,

COLONIAL.

Sir,—The letter in your issue of Saturday, April 1st, under the above heading, signed "Colonial," states that the Great Northern Telegraph Company's "representative in London" declared in an interview some months ago that the cable worked from the joint office (in Hong Kong), and introduced as a Danish cable, is now Russian property.

Permit me to point out—first, that I am not aware of having had any "interview" with anybody on the subject referred to for a whole year, or not since April, 1898 and the gist of my observations on that occasion to a representative of the *Westminster Gazette*, as quoted in that paper of April 27th, 1898, was quite the reverse of the statement attributed to me by "Colonial;" secondly, that I never made, nor could have made, any such statement—(1) because, as pointed out at the said interview, one of the very objects of the joint working arrangement of the two companies in the Far East was to leave the leadership and control of the Hong Kong station to the British company (the Eastern Extension Telegraph Company); (2) because the cable from Hong Kong to Amoy and further to Shanghai, Japan, and Siberia is, and always has been, the property of the Danish company, the Great Northern Telegraph Company, in whose service there is not a single Russian, but a number of Englishmen, and whose shares are more largely held in this than in any other country, while not a single share is held in Russia.

As to the relations of the company with foreign Governments, they are, happily, as intimate with the British as with the Russian and other Governments on whose territories our cables are landed.

The other invidious insinuations of "Colonial" I may safely leave unanswered; they are beneath notice.

I am, Sir, your obedient servant,

F. C. C. NIELSEN, the company's representative in England.

Great Northern Telegraph Company,
8, St. Helen's Place, E.C., *April 10th.*

Interruptions to Australian Trunk Landlines.—We are glad to see that at last those interested have begun to report to the International Bureau at Berne the occurrence of interruptions to Australian aerial lines. In this way the landlines will be made to bear their fair share of blame, some of which has undoubtedly hitherto been ascribed to the submarine cable. The last issue of the *Journal Télégraphique* reports that the South Australian landline was interrupted on March 23rd and restored same day, while the Western Australian landline was interrupted on the same date, being restored on March 29th.

The New German Trans-Atlantic Cable.—We are glad to see that the difficulties, which were anticipated, in the way of the extension of the Azores cable by Germany to the United States have been overcome, and at the end of last month complimentary telegrams passed between the German Emperor and President McKinley, in which the former thanked the latter for granting landing rights in the United States for a German cable. We understand that an English vessel, the *Britannia*, will shortly be despatched to take soundings along the proposed route of this cable, and we shall be anxious to know the result, as the late Sir James Anderson was, we understand, of opinion that it was impossible to lay a cable along this route. To the prospect of competition which will be created by this new German cable may be attributed the recent fall in the shares of the Anglo-American Telegraph Company, as this will prove a much more serious rival than wireless telegraphy, to which the fall in these shares has been ascribed. We understand that this cable will be made in Germany, at any rate in part, and doubtless when the work is all completed the English companies, which at present hold such large interest in the Emden-Vigo cable, will be able to retire from their ownership in favour of a patriotic German public. This German cable should doubtless have a large traffic, as it will probably secure all the German as well as other Continental trans-Atlantic messages.

Telegraphic Interruptions and Repairs:—

Cables.	Down.	Repaired.
Amazon Company's cable—		
Cable beyond Gurupa ...	June 11th, 1898 ...	...
French Company's cable—		
Cayenne-Pinheiro ...	March 10th, 1899 ...	May 2nd, 1899.
Para-Maranham	April 10th, 1899 ...	...
Landlines.		
Communication between Mossamedes and all Inland Offices.	March 16th, 1899 ...	...
Communication between Salonique and Monastir.	March 23rd, 1899 ...	...
Siberian landlines between—		
Irkoutsk-Werkhne Oudinsk	April 30th, 1899 ...	April 30th, 1899
Saigon-Bangkok ...	April 27th, 1899 ...	April 28th, 1899

CONTRACTS OPEN AND CLOSED.

OPEN.

Battersea.—June 7th. The Vestry wants tenders for the supply of mains, water-tube boilers, steam dynamos and engines. See "Official Notices" April 14th.

Birkenhead.—May 26th. The Corporation wants tenders for the supply and delivery of 100 electric meters. See "Official Notices" this week.

Blackpool.—May 10th. The Tramway Committee is inviting tenders for the taking up of the tramway line and conduit, and the relaying of new tramway lines on the carriage drive between Church Street and Adelaide Street. Particulars, &c., from the borough engineer.

Blackpool.—May 20th. The Tramways Committee wants tenders for ten bogie tramcars. See "Official Notices" to-day.

Crewe.—June 1st. The Corporation wants tenders for boilers and economisers, engines and dynamos, centrifugal pump and motor, mains, battery, switchboard, and travelling crane. See "Official Notices" this week.

Derby.—May 8th. The Corporation is just inviting tenders for the works in the superstructure in connection with the extensions to the electric lighting station, Sowter Road, Derby. Mr. Arthur Eaton, architect, 6, St. James's Street, Derby.

Ealing.—May 15th. The Ealing Council is now inviting tenders for two boilers with superheaters and accessories, as may be ascertained on reference to our "Official Notices" for April 21st.

Ealing.—May 15th. The Council is inviting tenders for steam, exhaust and other piping, &c., switchboard and connections, &c. See "Official Notices" April 28th.

Edinburgh.—May 15th. The Corporation wants tenders for the supply of copper strip for electric conductors. See our "Official Notices" April 28th.

Edinburgh.—May 22nd. The Council wants tenders for two steam driven fans for reduced draught. See "Official Notices" this week.

Epsom.—May 8th. The District Council wants tenders for various plant for its electricity undertaking, including boilers, dynamos, boosters, batteries, switchboard, crane, mains and roadwork, arc and incandescent lamps, and for the lighting of the station. See our "Official Notices" April 7th.

Fleetwood.—May 16th. The District Council wants tenders for lamps and lamp-posts for street arc and incandescent lighting, and also for wiring, switchboards, lamps, &c., for the Town Hall, Free Library, Market, and Slaughter House lighting. See "Official Notices" April 28th.

France.—May 9th. Tenders are being invited by the French Post and Telegraph Authorities in Paris for the supply of 20 kilometres of iron pipes 65 mm. diameter, for pneumatic pipe lines, in four lots. Tenders to be sent to Le Sous-Secretariat d'Etat des Postes et des Telegraphes, Rue de Grenelle, 103, Paris.

France.—May 12th. The French Post and Telegraph Authorities in Paris are inviting tenders until the 12th inst. for the supply of 92 kilometres of gutta-percha insulated electric cable. Particulars may be obtained from, and tenders are to be sent to, Le Sous-Secretariat d'Etat des Postes et des Telegraphes, Rue de Grenelle, 103, Paris.

Hackney.—June 13th. The Vestry invites tenders for trenching, troughing, cables, joint boxes, jointing and house services. See "Official Notices" this week.

Hampstead.—May 18th. For the purpose of extensions at the electricity works, the Vestry wants tenders for two 500-kw. steam alternators, five switchboard panels, boilers, feed water heaters, Weir's feed pumps, a 50-kw. exciter, water softening plant, air pump and condenser, Green's economiser and overhead crane. See "Official Notices" April 7th.

King's Lynn.—May 15th. The Corporation wants tenders for electric wiring and fittings for the Municipal Technical School. See our "Official Notices" April 28th.

London, W.—May 8th. The St. Marylebone Guardians want tenders for electric light wiring and fittings for the new front blocks of their workhouse, Northumberland Street, W. Bills of quantities and a form of tender, &c., upon application to Mr. A. Saxon Snell, F.R.I.B.A., architect, 22, Southampton Buildings, Chancery Lane, W.C., and depositing with him a £10 Bank of England note, returnable as usual.

London.—May 11th. The Great Eastern Railway Company wants tenders for stores and materials. For details of the various items (including telegraph materials). See "Official Notices" April 28th.

St. Pancras.—May 16th. The Vestry wants tenders for additional engines, dynamos, &c., at the Regent's Park Station. See "Official Notices" April 21st.

Southport.—May 17th. The Electricity Committee is inviting tenders for a C.I. tank, a centrifugal pump, and electric motor. See our "Official Notices" this week.

Teneriffe.—June 14th. Tenders are being invited until June 14th by the Spanish Ministry of Public Works in Madrid for the concession for the construction and working of an electric tramway between Santa Cruz de Teneriffe and San Cristobal de la Laguna, Teneriffe. Tenders to be sent to La Direccion General de Obras Publicas (Ministerio de Fomento), Madrid, whence particulars may also be obtained.

West Africa.—July 10th. The Compagnie de Mozambique, of 45, Rue do Alecrim, Lisbon, is inviting tenders until July 10th for the concession for the establishment and working of a central electric power station at Beira for lighting and power purposes during a period of 25 years. Particulars from, and tenders to, above.

CLOSED.

Aberdeen.—The contract mentioned last week as having been given out by the Corporation for 200-kw. traction generators has been withdrawn and been placed with Messrs. D. Bruce Peebles and Co., who can guarantee earlier delivery.

Belfast.—The engineer recently submitted a report on the tenders referred to him, and it was resolved that the tenders of Messrs. Wheeler & Co., for condensing plant, and Messrs. Babcock and Wilcox, for pipe work, be accepted.

Chatham.—The following tenders have been sent in for the electric lighting of the Town Hall and municipal buildings. Section A., wiring; section B., plain fittings:—

	Section A.	Section B.
Vaughan & Brown, Limited..	£902 0 0	£239 0 0
E. L. Berry, Harrison & Co..	924 14 0	156 1 3
Donnison, Berlyn, Sillem & Co.	799 0 0	227 0 0
P. C. Middleton & Co., Edinburgh	867 0 0	126 8 0
*Stevens & Barker, Maidstone	615 0 0	212 0 0

* Accepted.

The specifications were prepared by Mr. John Hewett, B.A., of Harrap, Hewett & Duffield.

Derby.—It is proposed to accept the tender of Mr. Henry Vernon for certain building operations for extending the electricity works (£2,030).

Glasgow.—Messrs. D. Bruce Peebles have secured the order from the Corporation for four 150-kw. sets for motor generators.

Hull.—The Works Committee last week accepted the tender of Messrs. Turner, Heason & Mitchell, of Manchester, amounting to £19,933 5s., for the execution of the foundation and paving of the Holderness Road section of the Hull electric tram system.

Liverpool.—The Tramways Committee has just considered the tenders submitted for electric cars for the proposed tramway extensions, and has placed an order for 80 cars at a cost of £490 each with Messrs. Dick, Kerr & Co., Limited. The total contract is thus £39,200.

FORTHCOMING EVENTS.

Saturday, May 6th. — The Institution of Electrical Engineers. Students' visit to be paid to Messrs. Siemens Bros. and Co. Train leaves Charing Cross for Charlton at 9.20 a.m.

Tuesday, May 9th.—At 3 p.m. Royal Institution. Prof. S. P. Thompson's second lecture on "Electric Eddy Currents."

Wednesday, May 10th.—At 7.30. Institution of Electrical Engineers (Students' meeting). Paper by H. M. Dousett on "Electricity Meters." Election of Committee.

Friday, May 12th.—At 9 p.m Royal Institution. Discourse by Prof. T. Preston, M.A., on "Magnetic Perturbations of the Spectral Lines."

Saturday, May 13th.—Institution of Electrical Engineers Students' visit to W. T. Henley's Telegraph Works. Train leaves Fenchurch Street 9.40 a.m.

NOTES.

The Wehnelt Interrupter.—Mr. Marchant, writing from the Blythswood laboratory to a contemporary, describes some highly successful experiments that have been made with this device. The multipolar form was found to be the most useful. The vessel containing the dilute acid was made of lead, and was itself the cathode. The anodes, six in number, were made of 18 mil. platinum wire, fused into glass tubes, and projecting $\frac{1}{20}$-inch from the ends of the tubes. It was found to be better to fit an ebonite plug into the end of the glass tube, into which the wire was tightly jammed, the whole tube being then filled with soft wax. The end of the platinum wire was silver-soldered to a copper terminal, mercury having been found inconvenient in use. It was found that the interrupter rapidly "fatigued," but this was discovered to be due to the acid getting hot, and, of course, can be obviated by some of the well-known methods of cooling liquids. By using a variable resistance in series with the interrupter, it was possible to get a large range of current; for instance, on a 50-volt circuit, currents varying from 1 to 25 amperes were sent through the primary of the coil. The great advantage of the multipolar arrangement was that a small current could be sent through the primary at a high frequency. When it was used in connection with an 18-inch coil and a suitable *X* ray tube, illumination of almost dazzling brilliancy was obtained on the fluorescent screen, while the tissues of the body showed almost as clearly as when a 16-plate Wimshurst machine was used to excite the tube, and with the same steadiness in the glow. M. Bary, in the *Comptes Rendus*, states that the Wehnelt interrupter goes through three distinct stages with an increasing E.M.F. When the E.M.F. is low, there is simply electrolysis; at a higher E.M.F. the electrolysis stops abruptly, and the humming noise sets in; at still higher E.M.F. the gases disengaged at the anode are no longer luminous, but the platinum turns red hot, and is surrounded by a layer of vapour. When there is no inductance in the circuit, the third stage follows the first.

Monument to Von Stephan.—A monument to the late Dr. Von Stephan, the first Postmaster-General of the German Empire and the originator of the Postal Union, was unveiled in Berlin on 1st inst.

American Mechanicals.—Next week, from the 9th to 12th inst., the American Society of Mechanical Engineers meets at Washington. A number of interesting subjects are down for papers, and there will be the usual excursions, receptions, &c., including a reception by President McKinley at the "White House" on Wednesday. Among the papers are the following :—

Stanwood, J. B.: "Standards for Direct-Connected Generating Sets."
Hale, R. S.: "Boiler and Furnace Efficiencies."
Emory, F. L.: "Test of a Steam Separator."
Henning, Gus C.: "Investigations of Boiler Explosions."
Professional Papers as follows:—
Emory, F. L.: "Relation Between Initial Tension and Power Transmitted by a Belt."
Henderson, George R.: "Manufacture of Car Wheels."
Darling, E. A. "The Power Plant of a University."
Fritz, John: "Rolling Mill Fly-Wheels."
Gordon, F. W.: "New System of Valves for Steam Engines, Air Engines and Compressors."

Electrical Coast Communication and the Lifeboat Service.—The Prince of Wales presided over a dinner in aid of the London Lifeboat Saturday Fund on Monday, and in the course of an interesting speech on the excellent work which is being accomplished by the Royal National Lifeboat Institution, reference was made to the subject of electrical communication. The Prince spoke as follows:—

One of the most important indirect measures adopted by the Institution with a view to diminish the loss of life from shipwreck on the coast has been to procure from the Government a system of electrical communication between rock lighthouses, light-vessels, &c., and the shore; also between the Coastguard stations and signal stations and the post offices nearest the lifeboat stations where there are no Coastguard stations. This useful work was commenced in 1893, and steady progress has been made in it every year, and it will, it is hoped, before long be completed. The Royal Commission which was appointed at the suggestion of the Institution in 1893 sat for four years, during which time they issued five reports, the fifth and final report being issued in the autumn of 1897. The most important recommendations of the Commission have already been carried out, but in their last report they felt bound to state that they did not feel justified in recommending the connection of more light-vessels and the shore than those they had proposed until the ethereal system then under trial had been fully tested. I understand that those tests have been satisfactory, and you have all doubtless seen in the Press the accounts of the remarkable and successful experiments which have recently been carried out in connection with wireless telegraphy under the superintendence of Signor Marconi, the inventor, which would seem to solve the great difficulties which have been encountered in the efforts made to complete so important a system round our coast. I should mention, likewise, the use and importance of the telephonic and telegraphic connections which have been established by the Institution, and the utility of which each year has been increasingly demonstrated, they being more and more employed for calling out lifeboats when required, for preventing unnecessary launches, and for warning lifeboat crews to be on the alert to render assistance.

Institution of Civil Engineers.—At the annual general meeting of the Institution of Civil Engineers, held on Wednesday last week, Mr. W. H. Preece, C.B., President, in the chair, the result of the ballot for the election of officers was declared as follows:—

President, Sir Douglas Fox; Vice-Presidents, Mr. James Mansergh, Sir William White, K.C.B., Mr. Charles Hawksley and Mr. John Clarke Hawkshaw, M.A.; other members of the Council, Mr. James Barton (Dundalk), Mr. Horace Bell, Sir Alexander Binnie, Dr. Henry Taylor Bovey, M.A. (Canada), Mr. T. Forster Brown (Cardiff), Mr. W. R Galbraith, Mr. George Graham (Glasgow), Mr. G. H. Hill, Mr. J. C. Inglis, Mr. Alexander Izat, C.I.E. (India), Dr. Alex. B. W. Kennedy, F.R.S., Sir James Kitson, Bart., M.P. (Leeds), Mr. Anthony George Lyster (Liverpool), Mr. John Allen McDonald (Derby), Mr. E. Pritchard Martin (Dowlais), Mr. William Matthews, Sir Guilford Molesworth, K.C.I.E., Sir Andrew Noble, K.C.B. (Newcastle), Mr. Alexander Siemens, Mr. Thomas Stewart (Cape Colony), Mr. John I. Thornycroft, F.R.S., Mr. William Thwaites, M.A. (Victoria), Mr. F. W. Webb (Crewe), and Sir E. Leader Williams (Altrincham).

Lectures.—A course of six lectures on "Rotary and Motor Transformers," by Mr. A. Schwartz and Mr. W. Beckit Burnie, will be delivered at the South-Western Polytechnic, Manresa Road, Chelsea, S.W., on Tuesdays, at 7.30 p.m., commencing on Tuesday, May 23rd.

Prof. C. A. Carus-Wilson is to deliver a course of eight lectures on "The Direct Current Motor" at the South-Western Polytechnic. The first lecture will be delivered on May 8th, at 7.30 p.m.

Automobile Trials.—The Automobile Club is arranging an automobile show (international) to be held at Old Deer Park, Richmond, Surrey, from Saturday, 17th, to Saturday, June 24th. Trials will be made of the various vehicles entered, and awards of medals and diplomas will be made. The following gentlemen have consented to act as judges:—

Prof. C. Vernon Boys, F.R.S.
Mr. W. Worby Beaumont, M.Inst.C.E.
Mr. Dugald Clerk.
Mr. Bryan Donkin, M.Inst.C.E.
Major Holden, R.A., F.R.S.
Prof. Hele-Shaw, LL.D, M.Inst.C.E.
Mr. W. H. Preece, C.B., F.R.S.
Mr. Boverton Redwood, F.R.S.E.
Sir David Salomons, Bart., J.P.
Mr. James Swinburne.

There are a number of classes, one being devoted to motor cycles, one to spirit motor vehicles, one to oil motor vehicles, others to electrical, steam, and other methods of propulsion. The electrical sections are as follows:—

Weighing under 1½ tons unladen.

Section 22. Passenger vehicles, to carry not more than three persons, including driver.
„ 23. Passenger vehicles, to carry four, or not more than seven persons, including driver.
„ 24. Passenger vehicles, to carry eight or more persons, including driver.
„ 25. Vans.

Weighing 1½ tons and under 2 tons unladen.

„ 26. Passenger vehicles.
„ 27. Goods vehicles.

Weighing 2 tons and under 3 tons unladen.

„ 28. Passenger vehicles.
„ 29. Goods vehicles.

Entries for the trials must be made not later than May 13th. Further particulars may be obtained from Mr. C. Johnson, the secretary, 4, Whitehall Court, S.W.

Presentations.—Mr. Alfred Lucas, on retiring from the position of superintendent of mains in the Sheffield electric light department, was on Saturday last presented by the staff with a handsome testimonial, consisting of marble clock, ornaments, and salver. Mr. Lucas, who has accepted an appointment with the British Thomson-Houston Company, Limited, has been associated with electrical developments in Sheffield for the past 14 years.

On 28th ult. Mr. McCowen, Belfast, city electrical engineer, presented Mr. M. C. Ollson with a handsome travelling bag on behalf of the staff, on the occasion of his departure to take up a post at Dublin.

The Institution of Electrical Engineers.—The following is a list of the nominations announced last Thursday for the vacancies on the Council at the end of the current year:—

For president, Prof. Silvanus P. Thompson, D.Sc., F.R.S.
As ordinary members of Council (five vacancies), Major P. Cardew, R.E., Mr. John Gavey, Mr. Robert Hammond, Mr. A. J. Lawson, and Mr. R. Percy Sellon.
As associate members of Council, Mr. Roger W. Wallace, Q.C., and Mr. Arthur Wright.
As honorary auditors, Mr. F. C. Danvers and Mr. E. Garcke.
As honorary treasurer, Prof. W. E. Ayrton, F.R.S.
As honorary solicitors, Messrs. Wilson Bristows & Carpmael.

An Electric Fire Engine.—The *Daily Mail* Paris correspondent says that the chief authorities of the firemen in Paris have at length, after months of study and experiment, arrived at a satisfactory type of fire engine of which the motor force is electricity. A new electric engine, capable of seating a dozen persons, and travelling at the average rate of 15 miles an hour, and ascending hills easily and stopping quickly, has been built, and will be in use from June 1st.

Electric Motor Dust Cart.—The Glasgow Corporation has passed a minute of the sub-committee on the collection, removal, and disposal of city refuse, to accept the offer of the Motor Car Syndicate, Limited, Glasgow, to provide for £532 an electric motor van for the collection of refuse. The step is only an experiment.

Wireless Telegraphy.—On Friday last week during a dense fog the East Goodwin Lightship, which is fitted with Marconi's wireless telegraph apparatus, was run into by a London steamship and suffered a certain amount of damage. The captain of the lightship was able to telegraph by the Marconi system to the South Foreland Lighthouse, giving all particulars of the occurrence. This instance is important as demonstrating one of the great advantages which may be expected to follow the use of wireless telegraphy for life-saving purposes round the coast. It may be mentioned that the vessel was at the time moored about 12 miles from the lighthouse in question. The wireless telegraph installation for the Dieppe and Newhaven service is to be proceeded with at once, and in addition to that on either side of the Channel the apparatus will be set up in the Channel steamers, the service being the first to adopt the system. The distance between Dieppe and Newhaven is 75 statute miles. The French Commission have suspended operations for a fortnight, in order to prepare a report on the subject for presentation to the French Government. The experiments have been completely successful. The French despatch vessel *Ibis*, which was fitted with Marconi's apparatus for the recent Channel experiments, was on Monday anchored off Sangatte, a village on the coast several miles west of Calais, and then communication was established with the station at Wimereux. The bold promontory of Cape Grisnez, intervening between the two points, which are about 20 miles apart, in no way interfered with the reception of the messages by the ship or the land station. The experiments were carried out under the direction of French officers.

"Compressed Air."—We have received a copy of No. 2 of Vol. iv. of this journal, which is devoted to the useful application of compressed air, and on the whole it is a fair and reasonable partisan of air. Compressed air has such a multitude of uses, that we think it is something of a mistake to push its use in general tramway traction. Air loses much in compression and re-expansion, and this very fact makes it more valuable in certain situations, such as mining, than any other agent, for it affords a much needed ventilation, and serves also as a cooling agent. Like electricity, compressed air is, after all, merely a medium of power transference; it is not a prime mover, but it absorbs power, and gives it out again, and certain losses are inevitable in the process just as they are in the manufacture and transport and use of electricity. But the loss in air is very great. Work goes in the shape of heat, and it goes in large quantity. But this is no argument against the use of air, and may be an argument at times in its favour. As the journal before us states, compressed air is supplemental to electricity. They are rather allies than rivals, and both have done much in industry, and are likely to do very much more than they have already accomplished.

Photographing Wireless Signals.—An evening contemporary says that some very successful experiments have been made by Mr. Harry Price, of Brockley, in wireless telegraphy. The stations were the top of the tower of St. Mark's Church, Brockley, and the top of Aske's boys' school at Telegraph Hill, Hatcham. Photographs were taken of the currents, showing the difference between the "dot and dash" system of the Morse alphabet by the large and small blurrs on the photographic plate. The apparatus is called the Patchett-Price telephoto apparatus (wireless), and the experiments were made with the ultimate view of photographing the message upon the sensitised film. It is stated that words at the rate of 25 per minute were telegraphed. The next experiment will be between the Crystal Palace and St. Peter's Church.

Personal.—Mr. C. H. Garland has been selected by the London telegraph clerks to represent them at the International Conference of Telegraphists at Como from May 3rd to June 3rd.

Royal Institution.—Last Friday evening Prof. Carus-Wilson lectured on "Some Features of the Electrical Induction Motor."

Ozone.—In the Commons on Tuesday Sir J. Leng asked Mr. Akers-Douglas whether the attention of his department had been directed to the possibility of supplying ozone to the House of Commons. Mr. Akers-Douglas replied in the affirmative, but the cost of the necessary installation would be some thousands of pounds, and he did not think the House would entertain the idea.

Appointments Vacant.—The Fulham Vestry wants a clerk of works for the electric light installation, capable of holding the appointment of resident engineer after completion. Salary £26 per month. See "Official Notices" this week.

The Belfast Corporation wants an assistant electrical engineer at £200 a year. See "Official Notices."

The Scotch Water-power Scheme.—After a fight of nine days before a Committee of the House of Commons, with Sir J. Kitson in the chair, an interesting scheme, promoted by Lord Tweedmouth, Lord Kelvin, the Earl of Crawford, and other well-known men, was defeated on Tuesday. They proposed to supply all Scotland with electricity by water-power. They would have established a generating station on the shores of Loch Leven, Inverness-shire, and would have taken power from that lake and others in the district. They have been overthrown chiefly by local authorities, who pleaded that their supplies of water would be interfered with.

Liquid Hydrogen.—At the annual meeting of the members of the Royal Institution, held on May 1st, Prof. Dewar made a brief reference to the recent scientific work of the Royal Institution, and announced that having obtained liquid hydrogen in considerable quantity he had directly determined its temperature and other physical constants, finding its boiling point to be much lower than was previously supposed—namely, 20° above the zero of absolute temperature, and attaining by exhaustion a temperature of only 15° absolute. Pending the discovery in quantity of some yet lighter gas, there was no means in sight of bridging this gap and reaching the zero point. He also took occasion to warn the public against absurd exaggerations as to the properties of liquid air, which, originating in America, found their way into popular magazines in this country.

American Civil Engineers.—At New York Mr. Desmond Fitzgerald has just been elected president of the American Society of Civil Engineers. We ought to mention that the gentleman referred to is an eminent American engineer with very large experience in waterworks matters, and is not the Mr. Desmond G. Fitzgerald, whose name is so well known to electrical engineers in London.

Sir Salter Pyne.—The *Pall Mall* says that Sir Thomas Salter Pyne, once the Ameer of Afghanistan's chief engineer, is now on his way home. Sir Thomas, who has left his partner to make the best arrangement he can with the Ameer, intends to settle down here.

Personal.—Mr. A. Bromley Holmes, the Liverpool Corporation electrical engineer, is the new president of the Liverpool Engineering Society.

NEW COMPANIES REGISTERED.

Telephone and Switchboard Syndicate (Continental), Limited (61,770).—This company was registered on April 27th, with a capital of £10,000 in £10 shares, to acquire, develop, turn to account and deal with any patents, rights, inventions, concessions, licences, &c., and to carry on business as financiers, promotors of companies, underwriters, concessionaires, capitalists and merchants. The first subscribers (each with one share) are:—W. H. Sinclair, 8, Ducie Street, Oxford Road, Manchester, secretary; Arthur E. Cowley, Thornfield, Priory Road, Sale, cashier; William Cawthorne, 2, Florence Street, Hightown, Manchester, clerk; John D. Haddock, 88, Broughton Lane, Manchester, secretary; Eugene Chevalier, 70, Derby Street, Hulme, Manchester, book-keeper; Sam Smith, 24, Linwood Street, Hulme, Manchester, clerk; and Charles E. Craig, 59, Bradshaw Street, Manchester, book-keeper. The subscribers are to appoint a manager or managers, who are to have sole control. Remuneration, 15 per cent. of the net profits.

Edison-Bell Automatic Phonographs (London and Provincial), Limited (61,601).—This company was registered on April 19th, with a capital of £40,000 in £1 shares, to acquire certain machines, instruments, apparatus, and rights from the Edison-Bell Consolidated Phonograph Company, Limited, and to carry on the business of manufacturers and exhibitors of and dealers in phonographs, graphophones and telephones, electricians, electrical and mechanical engineers, and suppliers of electricity. The first subscribers (each with one share) are:—F. H. Booth, 25, Mosley Street, Manchester, cotton manufacturer; A. J. Pheszey, 5, Holland Street, Kensington, agent; J. A. Milne, A.C.A., Park House, Anerley, S.E.; C. W. Groos, 106, Fenchurch Street, E.C., merchant; A. W. Shaw, Manor House, Over Haddon, Bakewell, gentleman; J. A. Wormald, 14, The Park, Eccles, commission agent; E. L. Phillips, 140, Cheapside, E.C., auctioneer. The first directors (to number not less than two nor more than 10) are to be nominated by the subscribers; qualification, 250 shares; remuneration, £200 each per annum (£300 for the chairman) and a share in the profits.

British Electric Works Company, Limited (61,640).—This company was registered on April 20th, with a capital of £135,000 in £1 shares (50,000 £6 per cent. cumulative preference), to adopt an agreement with James B. Atherton, and to carry on the business of electric lamp, meter, switch, cut-out, and general apparatus manufacturers, electricians, electrical and mechanical engineers, metal workers, cycle makers, &c. The first subscribers (each with one share) are:—Lloyd Higginbottom, Crown Iron Works, West Gorton, Manchester, engineer; Wm. M. Briggs, Bod-Alaw, Llandudno, gentleman; Jacob Atherton, Singleton, Huyton, Lancs., manufacturer; James B. Atherton, Manhattan, Gateacre, Lancs., manufacturer; David L. Chalmers, 5, Fenwick Street, Liverpool, chartered accountant; Wm. M. M. Forwood, 15, Union Court, Liverpool, solicitor; Gordon Sales, Pearl Assurance Buildings, St. John's Lane, Liverpool, secretary. The first directors (to number not less than three nor more than nine) are to be nominated by the subscribers; qualification, £250; remuneration, £200 each per annum (£250 for the chairman) and a share in the profits.

Edison-Bell Automatic Phonographs (Western Midland Counties), Limited (61,674).—This company was registered on April 22nd, with a capital of £11,000 in £1 shares, to adopt an agreement with the Edison-Bell Consolidated Phonograph Company, Limited, and to carry on the business of phonograph manufacturers and exhibitors, electricians, electrical and mechanical engineers, suppliers of electricity, metal workers, &c. The first subscribers (each with one share) are:—Frank Moore, Stephenson Street, Birmingham, ironfounder; Herbert Weldon, A.M.I.C.E., and Frank Morgan, C.E., Norwich Union Chambers, Chamberlain Square, Birmingham; Charles H. Smith and Arthur J. Williams, 77, Colmore Row, Birmingham, chartered accountants; Stephen J. Holliday, 86, Colmore Row, Birmingham, architect; W. Gibbs, 57, Colmore Row, Birmingham, metal broker. The first directors (to number not less than two nor more than seven) are Frank Moore, Stephen Holliday, John H. Sutton, and Herbert Weldon; qualification, 100 shares; remuneration, £150 per annum divided between them.

County of Durham Electrical Power Distribution Company, Limited (61,591).—This company was registered on April 19th, with a capital of £100,000 in £10 shares (5,000 preference), to carry on the business of electricians, electrical engineers and contractors, suppliers of electricity, chemical engineers, tramway and light railway proprietors, carriers, &c. The first subscribers (each with one share) are:—G. J. Somerville, 35, Shepherd's Bush Road, W., electrical engineer; C. Walmsley, 17, Priory Road, Kew, W., accountant; E. Garcke, Donington House, Norfolk Street, W.C., director; C. H. Dale, 36, Albacore Crescent, Lewisham, S.E., assistant secretary; W. E. Singleton, 2, Elm Villas, Elm Row, Hampstead, solicitor; Martin E. Sheerboom, 6, Fernciff Road, N.E., clerk; J. Renwick, 29, Hillside Road, Stamford Hill, N., clerk. The first directors (to number not less than three nor more than five) are to be nominated by the subscribers; qualification, £100; remuneration as the company may fix. Registered office, Surrey House, Victoria Embankment, W.C.

CITY NOTES.

Brockie-Pell Arc Lamp Company.

THE second annual report of this company, bringing the accounts up to December 31st, 1898, is now before us. The sales of the company have increased, so we are informed, by 70 per cent., while the loss on the business has decreased. Instead of a loss of £4,590 for 17 months

(a rate of £3,240 per annum) it has now a rate of £1,496 per year. The company is so far to be congratulated; on the other hand, the company has written nothing off plant and machinery ("as this has been maintained in thorough efficiency"), and the company has also had the benefit of £500 forfeit deposit for French and Belgian patents, and £675 as compensation for infringement of patents, &c. The directors, however, seem highly satisfied with the present management, and they apparently have a simple course now before them, namely, to still further reduce their expenditure, except that pertaining to the execution of orders, and to develop the business to the fullest on the strictest of business lines.

Cuba Submarine Telegraph Company.

The ordinary general meeting of this company was held at the offices of the company last Wednesday week, Mr. C. W. Parish in the chair.

The Chairman thought that he could congratulate them all upon the very favourable statements contained in the reports. The accounts were from July to December, and that period was one of vital importance to the island of Cuba, because it witnessed the destruction of the Spanish fleet at Santiago, the fall of that city to the Americans, and the peace between Spain and America. Last November he mentioned that owing to the skill and pluck of their representatives between Havana and the West Indies their business was maintained throughout the whole war. The lines were still working when the American army entered Santiago. A great deal of damage was done to their property owing to the Americans cutting their cables. Some repairs were completed when the last report was issued, and the remaining repairs had been carried out, so that at the present time their cables were in good order. Their six months' working had given them very satisfactory returns, after making due allowance for the accounts outstanding with the Spanish Government. The receipts were exceptionally large on account of Government business, and must not be regarded as a normal revenue. He would like to put on record that they were of opinion that the Spanish Government had treated them very fairly. There was, however, a sum still outstanding, which they should not put into the balance-sheet until it had been encashed, but they had practically agreed with the Government as to the amount which was to be paid. The expenses of the half-year were chiefly those of maintenance, and there was a great depreciation of cables and stores. They had made great inroad into their stock for repairing purposes, and found it desirable to reduce the value of what remained. The repairs to cables up to December 31st, during the war, cost £1,066, and since then they had paid, or were liable to pay, a further sum of £7,000. They were taking steps to bring the account before the notice of the United States Government. Their investments amounted in 1897 to £98,326, and at the present time they were £104,954, and they had been enabled to reduce the amounts owing to the banks. Taken as a whole, their list of investments was a very favourable one, and had increased in value in many items. As regarded the future, it was difficult to speak. There was considerable delay before the final settlement of the Treaty of Peace between Spain and America, and many important points were still unsettled. They would not be surprised to hear that the United States authorities were still examining the rights granted to different companies in Cuba. The British Foreign Office had given them every assistance and support, and Her Majesty's Ambassador at Washington laid before the Government their various concessions, and their last information from the Foreign Office was that the matter was under the consideration of the Departments of War and Justice, and that the result would shortly be submitted to the Cabinet. He trusted that at their next meeting he would be able to inform them that their concessions had been duly recognised. He moved the adoption of the report, together with the statement of accounts.

Mr. Keith, in reply to a shareholder, observed that the system of wireless telegraphy had only advanced to an experimental stage, and he did not think there was any need for alarm or anxiety as to its effect on their property.

The motion for the adoption of the report and accounts was seconded and carried.

Oriental Telephone and Electric Company.

The fifth ordinary general meeting of the shareholders of this company was held on Wednesday last week at Cannon Street Hotel, Sir Auckland Colvin presiding.

The Chairman proposed the adoption of the report, and said he was pleased to be able to congratulate the shareholders upon the results of the past year. The net balance of the revenue account was but little in excess of that shown in the previous year's accounts; the company had received from the Bengal Company a dividend of 5 per cent. instead of 7 per cent. on their holding in that company. The difference, however, had been more than made up by the increased earnings of the company and at their own branches. In the previous year the receipts were, to some extent, affected by an unusually favourable rate of exchange, but that was not the case in the year under review, so that the position was the more satisfactory in that, without the exchange, they had been able to make an excess of income as compared with last year. The board considered it advisable, for the present, at any rate, in the true interests of the shareholders, to limit the dividend to 5 per cent., and they were thus enabled to strengthen the company's resources by adding £2,000 to the reserve fund, increasing it to £3,000. The directors had sold £1,500 of the company's consols, and the proceeds had been invested in 5 per cent. debentures of their subsidiary company, the Telephone Company of Egypt, which had recently converted their 6 per cent. debentures into 5 per cent. debentures. The business of that company was extending in a most satisfactory manner, and that was a very important thing for them, because, roughly speaking, about a quarter of the company's net profits came to them from their holding in that company. At the end of January last Mr. Gréwing and he proceeded to Egypt with the object of obtaining from the Egyptian Government a renewal of the latter's arrangements by which the company supplied the telephone service of the Government. They were so far successful, that the previous arrangements had been renewed for a total period of 25 years, which would give the company in Egypt a very satisfactory and firm footing. So long as they held the Government telephone service they might consider that they were unassailable by any of their competitors. All the authorities and residents in Egypt with whom he came in contact during his visit were entirely satisfied with the way in which the Egyptian company's work was being proceeded with, and were very glad to give Mr. Gréwing and himself every assistance in their endeavours to form fresh arrangements with the authorities. With regard to the formal resolution which the shareholders would be asked to pass confirming the appointment of Mr. H. Johnstone Gréwing as a director, he might mention that that gentleman was now at Shanghai in connection with the tender that had been sent in to the Council of the Shanghai Settlements by the China and Japan Telephone Company. The directors of the company were hopeful of securing that concession, although at the present moment the result had not yet been made known. The motto of their company might be characterised as "prudence and progress," and he thought that as long as that was the case, affairs might go on as they were.

Mr. B. St. John Ackers seconded the motion, which was carried unanimously.

On the motion of the chairman, the two retiring directors, Messrs. B. St. John Ackers and Henry Gréwing, were re-elected.

Indo-European Telegraph Company, Limited.

Mr. J. Herbert Tritton, chairman, presided on Thursday last week at Winchester House over the ordinary general meeting of the members of the above company.

In moving the adoption of the report, the Chairman said the directors had to express their deep regret at the loss of the valuable services of Mr. H. H. Meier, of Bremen, who died last November, and who had been connected with the company since its commencement. The deceased was the organiser of the North German Lloyd line of steamers, which occupied a proud position in the shipping world. Dr. H. H. Meier, his son, would fill the vacancy on the board. They hoped also that they would soon be able to welcome Sir William Brooke, a former director of telegraphs to the Indian Empire, to a seat on the board. With regard to the accounts, the message business of the company for 1898 showed the satisfactory increase of £4 295 over that of 1897. The expected increase in the expenses, as foreshadowed by him when addressing them last year, had been realised owing to the erection of additional wires and the extended application of the Wheatstone automatic apparatus. They had again included, as a charge against revenue, an amount for writing down certain items of the capital account in pursuance of the policy which had commended itself to the shareholders of late years, and that of course would have a healthful influence upon the company's financial position, and tend to ensure permanently the prosperous character of the undertaking. The extension of the automatic transmission of the messages had now been completed, and had had a most satisfactory effect upon the celerity with which the traffic could be handled. They expected also to speedily bring the company's new wire into use, and that would enable them to handle a considerably larger business if it could be secured. It had been the policy of the board not to stand still but to carry out improvements where they were feasible, at the same time taking care to manage such operations without distressing the shareholders. They had still measures in contemplation for the future, which might possibly be carried out, or at least commenced, in the present year; but the same policy of graduating their operations would be pursued, and they believed that the shareholders would not feel them, except, perhaps, in the enhanced stability of the concern. Referring to the speech of Mr. Goschen the previous night on the relations existing between that country and France, Germany and Russia, the chairman said his utterances must be considered eminently satisfactory. For a long period the relations between the company and the Imperial Russian and German Telegraph Departments had been all that could be desired. As they knew, wireless telegraphy had made a great advance in the past few months, and probably it would be found to have a use in the duplex system of intercommunication under favourable conditions of limited purposes and limited distances, but the directors did not look upon it as a formidable rival. As to Mr. Henniker Heaton's suggestion for links of telegraph poles and wires through Afghanistan to ensure a great reduction of telegraphic charges between that country and India, the directors did not see the shadow of a formidable rival in the

proposal. The reserve fund of the company was most satisfactorily invested, and they had in contemplation further investments, as it must be remembered that the company's concessions were terminable, and the capital consequently might have to be replaced. In conclusion, he referred to the dividend, which was 6 per cent. for the year, and with the bonus it would be 10 per cent. for the year.

Mr. G. Holland seconded the motion, and it was agreed to.

Brockie-Pell Arc Lamp, Limited.

The second annual report of the directors, to be presented at the ordinary general meeting of the company to be held at Winchester House on Monday, May 8th, 1899, at 3 p.m., states that the directors have pleasure in submitting the accompanying profit and loss account and balance-sheet for the 12 months ending December 31st, 1898, being much more satisfactory than those of the previous 17 months, and showing a decided progress in the company's business, and a general improvement in its profits and management. The profit and loss account shows a debit balance of £1,496 15s. 5d. (as against £4,590 0s. 5d. for the preceding 17 months) but this includes £301 11s. 7d. written off the tools and patterns (as against £59 12s 3d. only in the previous account); legal expenses £386 6s. 9d., also £472 12s., special payments made to close expert and former management expenses (amounting to £1,160 8s. 4d.) the greater part of which are not likely to occur again. The sales of the company's lamps during the last year show an increase of over 70 per cent. compared with the preceding 17 months. The company have during the last year supplied their patent lamps to Ashton-under-Lyne, Morecambe, and Paisley, and their continued approval has been shown from their having received important repeat orders from the corporation of Bristol, and from the Hammersmith, St. Pancras, and Shoreditch Vestries. They are now occupied on an important contract for some hundreds of lamps for the Great Central Railway. On the introduction of the chairman, the company's lamps have been erected for H.R.H. the Prince of Wales at Marlborough House. Shortly after the last yearly meeting the directors, to get into closer touch with their shareholders, convened a meeting of those holding the largest number of shares, and in the result a committee was appointed, who went thoroughly into the affairs of the company. That committee, which was presided over by Mr. Shrimpton, did most valuable work, and as Mr. Pell at this juncture resigned, the directors felt they could not do better than urge Mr. Shrimpton to accept the position thus vacated of managing director, which he eventually accepted on terms very favourable to the company. The directors feel they cannot speak too highly of their satisfaction in the results of this appointment, as Mr. Shrimpton has shown himself most capable, energetic, and successful in the conduct of the business. The directors also, with a view to further economies, have reduced their fees to one-half, closed the head office, and moved the staff to the company's works. The contract for the sale of the Belgian and French patents has not been completed, and the £500 paid as deposit has, therefore been forfeited to the company. Other negotiations are in hand, and the directors will continue to use their best endeavours to realise these patents. As intimated at the last general meeting, the directors had taken proceedings against Messrs. Johnson and Phillips (the late makers of the lamp) for continuing to make lamps which they were advised infringed the company's patents. The directors, however, are glad to say such proceeding have been settled, that firm consenting to an order of the Court restraining them from manufacturing or selling Victoria lamps, and from in any other way infringing the said patents. Messrs. Johnson and Phillips have also undertaken not to issue any advertisements which may lead to the belief that they are entitled to manufacture or sell Brockie-Pell lamps or any lamps under license from the company. In addition, the firm have paid to the company the amount named in the profit and loss account for compensation. Nothing has on this occasion been written off plant and machinery, as this has been maintained in thorough efficiency. The inadequacy of the company's works to cope with the company's growing business is proving a serious difficulty, and the directors are carefully considering the question of larger and more suitable premises. Under the articles of association, Lord Suffield is the retiring director, but, being eligible, offers himself for re-election. The auditors, Messrs. Mellors, Basden and Co., also offer themselves for re-election.

The City and South London Railway Company.

A special meeting of the shareholders took place at the offices of the company on Tuesday, for the purpose of considering, and, if thought fit, approving the provisions of a Bill "to confer further powers on the City and Brixton Railway Company for the construction of an extension railway and works in the County of London, and for other purposes."

Mr. Charles Grey Mott, who presided, said that 12 months ago they completed an arrangement with the City and Brixton Company by which they undertook to complete a portion of the line between its junction with their old existing line near the Borough Station, and as soon as that line was completed to lease it in perpetuity for a term of 999 years, at a rental of £20,000 per annum, increasing by £1,000 annually until the maximum amount of £25,000 was reached. The Brixton Company were now asking Parliament to confer further powers upon them for the construction of certain works not included in the Bill previously passed, and the present meeting was called for the purpose of expressing approval of the new Bill, subject to such additions and alterations as Parliament might think fit to make. He moved that the new Bill should be approved.

A Shareholder: Is it not possible for our line to be taken on to Liverpool Street?

The Chairman: No; I hardly think Liverpool Street is the point which we desire to aim at, because our main line will go to the Bank, and it is the intention of the Central London Railway Company to go to Liverpool Street.

A Shareholder: Are we to work part of the Brixton line if only part of it is constructed?

The Chairman: We shall not touch the line until it is handed over to us, certified by the Board of Trade. The whole line will then be worked as one complete line.

The resolution was seconded by Mr. M. Tate, and, without further discussion, carried unanimously.

The Calcutta Electric Supply Corporation, Limited.

The second report of directors, to be presented at the annual general meeting of the shareholders of the company at the City Terminus Hotel, Cannon Street, in the City of London, on Friday, May 12th, 1899, at 2 o'clock p.m., states that the contractors have made good progress with the erection and equipment of the generating station and with the laying of the mains. Possession of the site was not obtained until March 10th, 1898, and the work of erection was not actually started until May 19th. The buildings were, however, practically finished at the end of last year, and are reported to be a good example of a central station, comparing favourably with any station in this country, the chimney being mentioned as exceptionally well built. Owing to the difficulty in settling the question of the overhead wires with the Government, to labour troubles, and to delay in delivery of some of the materials for the mains, the supply of electrical energy to the public was not commenced as early as was originally contemplated, but the works were opened and current started on the 17th inst. At that time there were applications registered for 2,000 lights and for power for a considerable number of electric fans. As was reported at the meeting last year, the Government of Bengal have confirmed their promise to renew the company's license at the expiration of the period of 21 years if the undertaking be not then purchased by the municipality or the Government, but confirmation is now coupled with conditions which the directors do not consider satisfactory, and the question is still under discussion. The Government of Bengal, in consideration of the delay in settling the question of the mains, have altered the date for the commencement of the company's license from January 13th, 1897, to October 20th, 1897. Application has been made for a large extension of the company's area of supply, embracing the south and south-west districts of Calcutta, including the Ballygunge and Alipore suburbs, in which many Europeans reside, and which are still being built on for European residences. This application has received the formal approval of the municipality and only awaits the confirmation of the Government. The board very much regret to report the death of Mr. Harrison Hayter, one of the directors of the company.

The Western and Brazilian Telegraph Company, Limited.

The report of the directors, to be presented at the thirty-seventh ordinary general meeting of the company, states that the total earnings amount to £79,103 18s. 7d., as against £72,332 9s. 10d., showing an increase of £6,771 8s. 9d. compared with the half-year to December 31st, 1897. The working expenses amount to £43,179 1s., as against £37,774 1s. 11d., an increase of £5,404 19s. 1d. Including the amount brought forward from June 30th, 1898, and the dividend receivable upon the shares held in the "Platino" Company, and after providing for income-tax, the balance to the credit of the revenue account is £39,204 8s., from which has been deducted £8,037 12s. 4d. for interest on debentures and debenture stock, £1,079 10s. has been placed to debenture stock redemption fund, and £9,000 to reserve fund, leaving a balance of £21,087 5s. 8d. The directors now recommend the payment of 4s. per share, free of income-tax, for the half-year on the ordinary shares, making, with the dividend paid in November last, 3 per cent. for the year, leaving a balance of £1,607 13s. 8d. to be carried forward. In the case of shares which have been divided into "preferred" and "deferred," the 4s. per share now recommended will be payable, viz:—3s. 9d. to the preferred shareholders (making up the full dividend of £5 per cent. on these shares to December 31st, 1898), and 3d. per share to the deferred shareholders. The iron barque, *Norna*, has been purchased and sent out to Brazil, to be used as a hulk for ships' stores and stock cable, and she has been fitted with the necessary machinery for renovating old cable picked up during repairs. The tenth annual drawing of the "A" and "B" debentures took place at the company's offices on January 25th last, in the presence of Mr. H. de Meray, notary public, when debentures amounting to £19,000 were drawn; of these £8,500 "A" and 9,800 "B" had already been exchanged for debenture stock, and the balance, viz., £700 "B" debentures have since been paid off at par.

The Brazilian Submarine Telegraph Company, Limited.

The report of the directors and the accounts for the half-year ended December 31st, 1898, to be submitted to the fifty-first ordinary general meeting, May 10th, 1899, states that the revenue for this period amounted to £115,159 0s. 3d., and the working expenses to £22,253 1s. 3d. After providing £3,200 for debenture interest and sinking fund, and £1,943 10s. 8d. for income-tax, there remains a balance of £87,762 8s. 4d.; to this is added the sum of £18,212 3s. 4d.,

dividends receivable from the Western and Brazilian Telegraph Company, Limited, and the London Platino-Brazilian Telegraph Company, Limited, and £8,963 19s. 7d. brought forward from June 30th last, making a total of £114,938 11s. 3d. The expenses consequent upon carrying out the arrangements for closer working union with the Western and Brazilian and the London Platino-Brazilian Telegraph Companies amounted to £7,568 19s. 11d. First and second interim dividends, amounting to £61,568 2s. have been paid, and £30,000 transferred to the reserve fund, leaving the sum of £15,801 9s. 4d. to be carried to the next account.

West Coast of America Telegraph Company.

The report for the year 1898, to be presented at the meeting to be held in London on 9th inst., states that the gross income for the year was £25,080. After providing for the working expenses (£18,841), and the interest on the 4 per cent. debentures, the net balance of profit was £239, and adding £34 brought forward from the previous year, leaves a balance of £274 to be carried forward. There has been little or no improvement in trade on the West Coast generally, and as a result of a financial crisis in Chili last July, there was a fall of about 33 per cent. in the rate of the Valparaiso exchange on London. Quite recently there have been signs of a reaction in the exchange, which may lead to a feeling of more security in business generally, now that friendly relations have been restored between Chili and the Argentine Republic. The company's cables, landlines, and the repairing steamer have been maintained in a state of efficiency.

The Western and Brazilian Telegraph Company, Limited.—The directors have, after transferring £9,000 (nine thousand pounds) to the reserve fund, decided to recommend at the forthcoming general meeting of shareholders a dividend of 4s. (four shillings) per share, free of income-tax, on the ordinary shares for the half-year ended December 31st, 1893, making, with the interim dividend paid in November last, a total distribution of 3 per cent. for the year 1898. In the case of shares which have been divided into "preferred" and "deferred" the 4s. per share now recommended will be payable, viz: 3s. 9d. (three shillings and ninepence) to the "preferred" shareholders (making up the full dividend of £5 per cent. on these shares to December 31st, 1898), and 3d. (three pence) per share to the deferred shareholders. The balance of the account subject to audit is carried forward. For the purpose of paying the above dividend on the 10th prox., the register of members and transfer books will be closed from Wednesday 3rd, until Wednesday, May 10th next, both days inclusive.

Elmores.—Shareholders in Elmore's Patent Copper Depositing Company, Limited, Elmore's Wire Manufacturing Company, Limited, Elmore's Foreign and Colonial Patent Copper Depositing Company, Limited, and Elmore's American and Canadian Patent Copper Depositing Company, Limited, are informed that the negotiations for the amalgamation of these companies and for the provision of ample working capital are now completed, and that Messrs. L. Hirsch & Co. have subscribed £200,000 (free working capital) in cash to the new company.

British Columbia Electric Railway Company, Limited.—The profits for the year ended March 31st, after deducting fixed charges and the preference dividend, amounted to £16,283, and the directors recommend a dividend on the ordinary shares of 4 per cent. per annum, tax free, and the carrying of £8,008 to special and general reserves.

Messrs. Ernest F. Moy, Limited.—At a recent meeting of the directors it was resolved to issue at once, at a premium of 2s. 6d. per share, 3,000 out of 5,000 ordinary shares authorised to be created and issued by the special resolutions passed and confirmed at the extraordinary general meeting held on April 10th and 26th.

TRAFFIC RECEIPTS.

The Blackpool and Fleetwood Tramroad Company.—The receipts for the week ending April 29th, 1899, were £293 14s. 9d.; aggregate to date, £3,941 1s. 4d.

The Bristol Tramways and Carriage Company, Limited.—The receipts for the week ending April 28th, 1899, were £3,068 6s. 11d.; corresponding period, 1898, £2,694 4s. 7d.; increase, £369 2s. 4d.

The City and South London Railway Company.—The receipts for the week ending April 30th, 1899, were £1,033; week ending May 1st, 1898, £988; increase, £44; total receipts for half-year, 1899, £19,358; corresponding period, 1898, £18,757; increase, £601. Miles open, 3½.

The Dover Corporation Electric Tramways.—The receipts for the week ending April 29th, 1899, were £158 11s. 8d.; week ending April 30th, 1898, £130 8s. 10d.; increase, £28 2s. 5d. Total receipts to date, 1899, £2,579 18s. 0d.; corresponding period, 1898, £1,951 11s. 0d.; increase, £628 7s. 0d. Miles of track open week ending April 29th, 1899, 8; week ending April 30th, 1898, 3. Car miles run week ending April 29th, 1899, 4,138; week ending April 30th, 1898, 3,108. Number of cars, week ending April 29th, 1899, 11; week ending April 30th, 1898, 7.

The Dublin United Tramways Company.—The receipts for the week ending Friday, April 28th, 1899, were as follows:—D. U. T. Co., horse cars, £1,753 5s. 10d.; ditto, electric cars, £998 1s.; D. S. D. Co., electric cars, £708 10s. 5d.; total, £3,459 17s. 3d.; corresponding week last year—D. U. T. Co., horse cars, £2,627 10s. 6d.; ditto, electric cars, £397 4s. 6d.; D. S. D. Co., electric cars, £505 13s. 1d.; total, £3,530 8s. 1d.; decrease, £70 10s. 10d.; aggregate to date, £56,507 19s. 6d.; ditto last year, £53,669 11s. 2d.; increase to date, £2,838 8s. 4d. Worked:—The mileage open is 18 miles electrically, 26 miles by horses, as against 11 miles electrically, and 31 miles by horses, for the corresponding period last year.

The Liverpool Overhead Railway Company.—The receipts for the week ending April 30th, 1899, amounted to £1,408; corresponding week last year £1,451; decrease, £43.

The South Staffordshire Tramways Company.—The receipts for week ending April 28th, 1899, were £657 8s. 6d.; aggregate receipts for 17 weeks, £10,467 8s. 11d.; week ending April 29th, 1899, £579 7s. 9d.; aggregate receipts for 17 weeks, £10,083 14s. 7d.

STOCKS AND SHARES.

Wednesday Evening.

The fact that May Day is a holiday in the Stock Exchange has tended to restrict business during the past week, while the excitement that has ruled once more within the mining markets is responsible for a withdrawal of public attention from the less speculative departments. Nevertheless, the general tone of the electric lighting section is remarkably good, and there have been considerable buying orders in the market for Charing Cross shares. The rumour runs that the Charing Cross Company will probably obtain the power which it seeks in order to combat the monopoly of the City of London Company within the Corporation's boundary. Whatever amount of truth there may be in the report, the insiders thought it sufficiently accurate to buy Charing Cross shares upon, and the price has risen ½ to 11½. This, however, merely restores the quotation to the level at which it stood a fortnight ago. It is a little singular to notice that there is no appreciable change in the shares of the other two companies which are also endeavouring to get into the City. Metropolitans at 16⅝ and Smithfield Market at 3⅝ are virtually the same as they were this time last week. We may observe, in passing, that it is high time the Smithfield Market Company bent resolutely to the necessity for having an official quotation for its shares. As long as these remain outside the pale of the Official List, dealing in the shares will always be more or less difficult and restricted.

It is so long since anyone heard anything at all favourable about the Elmore Companies that the latest feat of the directors of the four principal companies in amalgamating their various interests has excited no little surprise and comment. The circular from Leeds containing the notice of the amalgamation does not state what capital the combination will start with, but it will probably be about three-quarters of a million sterling, of which £200,000 free working capital has been subscribed by Messrs. L. Hirsch & Co., the well-known outside stockbrokers. Holders of the French Elmore shares will remember that the same firm rendered their company substantial aid in the past, and their present offer represents about one-third of the whole issued capital of the group as it stands at present. We can hardly criticise the move without further particulars, but in the meantime we should counsel shareholders to keep their shares. The price of both the Elmore Patent Copper Depositing and of the Elmore's Wire Manufacturing shares was normally 10s. to 15s., and it is now a shade harder at ⅝—¾.

Mr. Rhodes's brave speech at the Cannon Street Hotel last Tuesday has brought some inquiries into the market for the shares of the African Trans-Continental Telegraph Company. As a long shot, we are of opinion that the shares are worth buying if they can be picked up at about 5s. Not much more than 12 months since, the shares were on offer at 1s. each, but the Imperial schemes of the Colossus are not viewed through spectacles of a different colour to those that were assumed when the Jameson raid was still in sight. The Telegraph Market has not had a very happy week on the whole, and prices are down in most cases. Anglo-American issues have suffered, owing to uneasy talk about that Old Man of the Sea, the new German cable. Eastern stock has fallen to 162½, it being feared that the coming Pacific line will entail a severe reduction in tariffs, and also that Mr. Rhodes's scheme will injure the African service. Eastern Extension and Globes are both quoted ex-dividend. Globe Preference have weakened ¼. Some quiet buying of National Telephone shares resulted in a rise of ⅛. The directors of the Brockie-Pell Arc Lamp, Limited, are evidently cheerful men. The profit and loss account (showing a debit balance of £1,497) and balance-sheet for the year are described as exhibiting a "decided progress in the company's business and a general improvement in its profits (!) and management." The company received little windfalls of £1,175 for forfeiture of deposit and compensation for patents infringed in addition to the "profits." The Stock Exchange puts the nominal value of $\frac{1}{16}$—¼ on the shares, and there is a buyer about at 4s.

The New General Traction report reads favourably, and the shares have been largely dealt in round about 4, which is ¼ up. There is very little going on in Tramway and Traction descriptions in London, but in New York another substantial fall in Electric Traction shares has been brought about by the proposed municipal taxation. The British Columbia Electric Railway is about to distribute 4 per cent. on its Ordinary shares, a showing which can only be regarded as satisfactory. Western and Brazilian shares are unaffected by the issue of the report.

SHARE LIST OF ELECTRICAL COMPANIES.—TELEGRAPH AND TELEPHONE COMPANIES.

Present Issue.	NAME.	Stock or Share. ‡	Dividends for the last three years. 1896.	1897.	1898.	Closing Quotation, April 26th.	Closing Quotation, May 3rd.	Business done during week ended May 3rd, 1899. Highest.	Lowest
124,400l	African Direct Telegraph, 4 % Debs.	100	...	...	...	100 —104	100 —104	...	...
25,000	Amazon Telegraph, shares	10	...	...	...	3 — 4	3 — 4	...	..
125,000	Do. do. 5 % Debs. Red.	100	...	...	...	87 — 92	87 — 92	...	..
905,560l	Anglo-American Telegraph	Stock	£2 13s	3 %	£3 9s	62 — 63	61 — 64	63	62
3,047,220l	Do. do. 6 % Pref.	Stock	£5 6s	6 %	6 %	112½—113½	110½—111½	113	110½
3,047,220l	Do. do. Deferred...	Stock	...	...	18s. %	13¼— 13¾	12¼— 12¾	13⅝	12 7/16
205,151	Brazilian Submarine Telegraph	10	7 %	7 %	...	15¼— 15¾	15¼— 15¾	15¾	15¼
75,000l	Do. do. 5 % Debs. 2nd series, 1906 ...	100	...	...	...	110 —114	110 —114	...	...
44,000	Chili Telephone, Nos. 1 to 44,000	5	4 %	4 %	...	2½— 3	2½— 3	...	...
10,000,000$	Commercial Cable	$100	8 %	8 %	8 %	185 —195	185 —195	185½	...
1,332,523l	Do. do. Sterling 500 year 4 % Deb. Stock Red.	Stock	...	...	...	104 —106	104 —106	106	105
224,850	Consolidated Telephone Construction and Manufacturing	10/-	2 %	1½ %	...	1/16— 3/16	⅛— ¼	...	...
16,000	Cuba Telegraph	10	8 %	7 %	8 %	9½— 10½	9 — 10 xd	...	...
6,000	Do. 10 % Pref.	10	10 %	10 %	10 %	19 — 20	18½— 19½	18½	...
12,931	Direct Spanish Telegraph	5	4 %	4 %	...	4 — 5	4 — 5	...	...
6,000	Do. do. 10 % Cum. Pref.	5	10 %	10 %	...	9½— 10½	9½— 10½	...	...
30,000l	Do. do. 4½ % Debs., Nos. 1 to 6,000 ...	50	4½ %	4½ %	...	106 —109%	106 —109%	...	...
60,710l	Direct United States Cable	20	3 %	3¼ %	...	11 — 11½	11 — 11¼	11⅜	11⅛
120,000	Direct West India Cable, 4½ % Reg. Deb.	100	...	...	...	102 —105	102 —105	...	...
4,000,000	Eastern Telegraph, Ord. Stock	Stock	6½%	7 %	...	167 —172	161 —166	168½	162
1,795,000	Do. 3½ % Pref. Stock	100	...	...	...	101 —104	101 —104	103½	102¾
89,900	Do. 5 % Debs., repayable August, 1899 ...	100	5 %	5 %	...	100 —103	100 —103	...	...
1,432,268l	Do. 4 % Mort. Deb. Stock Red.	Stock	4 %	4 %	...	123 —127	121 —125 xd	123	121
250,000	Eastern Extension, Australasia, and China Telegraph ...	10	7 %	7 %	7 %	16½— 17	16 — 16½	16⅝	16
16,200l	Do. 5 % (Aus. Gov. Sub.) Deb., 1900, red. ann. drgs., reg. 1—1,049, 3,976—4,326	100	5 %	5 %	...	99 —103	99 —103	...	...
64,400l	Do. do. Bearer, 1,050—3,975, 4,327—6,400	100	5 %	5 %	...	100 —103	100 —103	...	...
320,000l	Do. 4 % Deb. Stock	Stock	4 %	4 %	...	123 —127	123 —127	123	...
35,100l	Eastern and South African Telegraph, 5 % Mort. Deb., 1900 red. ann. drgs., Reg. Nos. 1 to 2,343	100	5 %	...	...	99 —103	99 —103	...	...
46,500l	Do. do. do. to bearer, 2,344 to 5,500	100	5 %	...	...	100 —103	100 —103	...	...
300,000l	Do. 4 % Mort. Debs., Nos. 1 to 3,000, red. 1909	100	4 %	...	...	102 —105	102 —105	...	...
200,000l	Do. 4% Reg. Mt. Debs. (Mauritius Sub.) 1—8,000	25	4 %	...	...	104 —107%	102—105%xd	...	...
180,227	Globe Telegraph and Trust	10	4½ %	4½ %	5⅛ %	11⅜— 12¼	11½— 12 xd	12	11⅝
180,042	Do. do. 6 % Pref.	10	6 %	6 %	6⅝ %	15¾— 16¼	15½— 16 xd	16	15½
150,000	Great Northern Telegraph, of Copenhagen...	10	10 %	10 %	...	31 — 32	31 — 32	31⅛	...
92,600	Halifax and Bermuda Cable, 4½% 1st Mort. Debs., within Nos. 1 to 1,200, Red.	100	...	...	...	100 —103	100 —103	...	...
17,000	Indo-European Telegraph	25	10 %	10 %	10 %	57 — 60	57 — 60	59	57⅛
100,000l	London Platino-Brazilian Telegraph, 6 % Debs.	100	6 %	6 %	...	108 —111	108 —111	...	...
490,000	National Telephone, 1 to 490,000	5	5½ %	6 %	6 %	4 — 4½	4½— 5	4⅝	4⅜
15,000	Do. 6 % Cum. 1st Pref.	10	6 %	6 %	6 %	11 — 13	11 — 13	12	11⅜
15,000	Do. 6 % Cum. 2nd Pref.	10	6 %	6 %	6 %	11 — 13	11 — 13	...	...
250,000	Do. 5 % Non-cum. 3rd Pref., 1 to 250,000	5	5 %	5 %	5 %	4¾— 5¼	4¾— 5¼	5	4⅞
1,329,471l	Do. 3½ % Deb. Stock Red.	Stock	3½ %	3½ %	3½ %	99 —102	99 —102	99½	...
171,504	Oriental Telephone and Elec., Nos. 1 to 171,504, fully paid	1	5 %	5 %	5 %	⅞— 1	⅞— 1 xd	...	...
100,000l	Pacific and European Tel., 4 % Guar. Debs., 1 to 1,000 ...	100	4 %	4 %	...	105 —108	105 —108	...	...
11,839	Reuter's	8	5 %	5 %	...	7 — 8	7 — 8	...	...
3,381	Submarine Cables Trust	Cert.	...	...	...	137 —142	130 —135	...	...
58,000	United River Plate Telephone	5	5 %	6 %	...	4¾— 5¼	4¾— 5¼	...	...
151,733l	Do. do. 5 % Debs.	Stock	...	...	...	104 —107	104 —107	...	...
200,000l	West African Telegraph, 5 % Debs.	100	5 %	5 %	...	99 —102	99 —102	...	...
30,008	West Coast of America, Nos. 1—30,000 and 53,001—53,008	2½	...	...	...	½— 1	½— 1	...	...
150,000	Do. do. 4% Debs., 1—1,500 gua. by Braz. Sub. Tel.	100	...	...	...	103 —106	103 —106	...	...
389,521	Western and Brazilian Telegraph 4 % Deb. Stock Red. ...	Stock	...	...	...	106 —109	106 —109	...	...
88,321	West India and Panama Telegraph	10	1 %	2%	...	2 — 2¼	2 — 2¼	2	...
34,563	Do. do. do. 6 % Cum. 1st Pref. ...	10	6 %	6 %	...	10¾— 11¼	10¾— 11¼	...	...
4,669	Do. do. do. 6 % Cum. 2nd Pref. ...	10	6 %	6 %	...	9 — 10	9 — 10	...	...
80,000l	Do. do. do. 5 % Debs., Nos. 1 to 1,800	100	5 %	5 %	...	105 —108	105 —108	...	...
158,100l	Western Union of U.S. Telegraph, 6 % Ster. Bonds ...	100	6 %	6 %	...	100 —105	100 —105	...	...

ELECTRICITY SUPPLY COMPANIES.

30,000	Charing Cross and Strand Electricity Supply	5	6 %	7 %	8 %	10½— 11½	11 — 12	11¼	...
20,000	Do. do. do. do. 4½ % Cum. Pref.	5	...	...	...	5⅜— 6¼	5⅜— 6¼	...	...
34,000	*Chelsea Electricity Supply, Ord., ...	5	5 %	6 %	6 %	7½— 8½	7½— 8½	...	...
100,000	Do. do. do. % Deb. Stock Red....	Stock	4½ %	4½ %	...	114 —116	114 —116	...	...
60,000	City of London Electric Lighting, Ord. 40,001—100,000 ...	10	7 %	10 %	6 %	17½— 18½	17 — 18	18	17½
40,000	Do. 6 % Cum. Pref., 1 to 40,000	10	6 %	6 %	6 %	15 — 16	15 — 16	15⅝	15⅜
400,000	Do. 5 % Deb. Stock, Scrip. (iss. at £115) all paid	...	5 %	5 %	...	124 —129	124 —129	...	...
40,000	County of Lond. & Brush Prov. Elec. Ltg., Ord. 1—40,000	10	*nil*	*nil*	*nil*	11 — 12	11 — 12	11¼	11 1/16
20,000	Do. do. do. 6 % Pref., 40,001—60,000	10	6 %	6 %	6 %	14 — 15	14 — 15	14⅜	...
17,400	Edmundsons Elec. Corp., Ord. Shares 1—17,400	5	...	5 %	...	5½— 5⅝	5½— 5⅝	5½	5 7/16
19,661	House-to-House Electric Light Supply, Ord., 101 to 19,661	5	...	4 %	6 %	8½— 9½	8½— 9½	...	...
12,000	Do. do. 7 % Cum. Pref. ...	5	7 %	7 %	...	9 — 10	9 — 10	...	...
110,000	London Electric Supply Corporation, Limited, Ord. ...	3	...	...	...	3¼— 3⅜	3¼— 3⅜	...	...
45,	Do. do. do. 6 % Pref.	5	...	...	6 %	6½— 7	6½— 6¾	6¾	6½
100,000	Do. do. do. 4% 1st Mt. Db. Stock Rd.	Stock	...	...	...	106 —108	106 —108	...	...
62,500	Metropolitan Electric Supply, 101 to 62,500	10	5 %	6 %	5 %	16½— 17½	16½— 17½	16⅝	16¾
22,500	Do. Nos. 62,501 to 85,000, £7 paid ...	10	...	...	...	12½— 13½	12½— 13	...	...
220,000l	Do. 4½ % First Mortgage Debenture Stock	...	4½ %	4½ %	...	118 —121	118 —121	...	...
6,452	Notting Hill Electric Lighting	10	4 %	6 %	6 %	16½— 17½	16½— 17½	...	...
31,980	St. James's and Pall Mall Electric Light, Ord.	5	10½%	14½%	14½%	17 — 18	17 — 18	17½	...
20,000	Do. do. 7 % Pref., 20,081 to 40,080	5	7 %	7 %	7 %	9 — 10	9 — 10	...	...
65,000	South London Electricity Supply, Ord., £3 paid	5	...	...	...	3¼— 3½	3¼— 3½	...	...
79,900	Westminster Electric Supply, Ord., 101 to 80,000 ...	5	9 %	12 %	12 %	15 — 16	14½— 15½	15½	15¼

* Subject to Founder's Shares.
† Quotations on Liverpool Stock Exchange.
Unless otherwise stated all shares are fully paid.
‡ Dividends paid in deferred share warrants, profits being used as capital.
Dividends marked ‡ are for a year consisting of the latter part of one year and the first part of the next.

SHARE LIST OF ELECTRICAL COMPANIES—*Continued.*

ELECTRICAL RAILWAY, MANUFACTURING, AND INDUSTRIAL COMPANIES.

Present Issue.	NAME.	Stock or Share. ‡	Dividends for the last three years. 1896.	1897.	1898.	Closing Quotation April 26th.	Closing Quotation May 3rd.	Business done during week ended May 3rd, 1899. Highest	Lowest.
60,000	Aluminium "A" shares, Nos. 1—60,000	1	10 %	10 %	...	2¾— 3½	3 — 3½	...	...
90,000	Do. 4½ % 1st Mort. Deb. Stock Red.	Stock	...	...	...	95 —100	95 —100	...	...
30,000	British Electric Traction	10	...	...	6 %	18½— 19	18½— 19½	19	18⅞
10,000	Do. do. 6 % Cum. Pref. 30,001—40,000 (issued at £2 10s. prem. all pd.)	10	...	...	...	13¾— 14½	13¾— 14½	...	...
200,000	Do. do. 5 % Perpetual Debenture Stock ...	Stock	...	...	...	126 —129	126 —127	129	...
90,000	Brush Elecl. Enging., Ord., 1 to 90,000	3	*nil*	*nil*	...	1⅞— 2⅛	1⅞— 2⅛	2 1/16	...
90,000	Do. do. Non-cum. 6 % Pref., 1 to 90,000	2	*nil*	4 %	...	2⅛— 2⅜	2⅛— 2⅜	2⅜	2¼
125,000*l*	Do. do. 4½ % Perp. Deb. Stock ...	Stock	...	...	...	110 —114	110 —114	...	...
50,000	Do. do. 4½ % 2nd Deb. Stock Red. ...	Stock	...	...	...	102 —105	102 —105	...	...
20,000	Callender's Cable Construction shares, Nos. 1—20,000 ...	5	10 %	12½%	...	12½— 13	12½— 13	12¾	...
90,000	Do. do 4½ % 1st Mort. Deb. Stock Red.	Stock	...	...	...	114 —117	114 —117	...	...
35,250	Central London Railway, Ord. Shares	10	...	...	...	9¾— 10⅛	10 — 10⅛	10⅛	9 15/16
178,303	Do. do. do. £8 paid	10	...	...	...	7⅞— 8⅛	8 — 8⅛	8⅛	7 15/16
61,033	Do. do. Pref. half-shares £3 paid ...	...	...	...	...	3¼— 4	3½— 4	...	...
71,447	Do. do. Def. do. £5 paid ...	...	...	...	...	4¼— 4⅝	4½— 5	4⅝	4 7/16
630,000*l*	City and South London Railway	Stock	1 9/16 %	1⅞%	2⅛%	68 — 70	68 — 70	69	...
22,500	Do. do. Ord. shares, Nos. 1 to 22,500 £5 pd.	10	...	...	...	4¾— 5⅛	4¾— 5⅛	...	...
32,098	Crompton & Co., Nos. 1 to 32,098	3	...	...	...	3¼— 3⅜	3¼— 3⅜	...	...
100,000	Do. 5% 1st Mort. Reg. Debs., 1 to 900 of £100, and 901 to 11,000 of £50 Red.	...	...	...	...	98 —101	98 — 101	...	...
99,261	Edison & Swan Utd. El. Lgt., "A" shares, £3 pd. 1 to 99,261	5	5⅛%	6 %	...	2 — 2⅛	2 — 2⅛	2 1/16	2⅛
17,139	Do. do. do. "A" Shares, 01—017,139	5	5⅛%	6 %	...	4 — 5	4 — 5	...	...
344,023	Do. do. do. 4 % Deb. Stock Red. ...	100	...	...	...	96 — 98	96 — 98	...	...
112,100	Electric Construction, 1 to 112,100	2	5 %	6 %	6 %	2 — 2¼	2⅛— 2⅜	2⅜	2⅛
25,000	Do. do. 7 % Cum. Pref., 1 to 25,000 ...	2	7 %	7 %	7 %	3 — 3½	3 — 3½	...	...
140,300	Do. do. 4% Perp. 1st Mort. Deb. Stock ...	Stock	...	...	...	103 —106	103 —106	...	...
91,196	Elmore's Patent Copper Depositing, 1 to 70,000	2	...	...	...	½— ¾	½— ¾	...	...
67,275	Elmore's Wire Manufacturing, 1 to 69,385, issued at 1 pm.	2	...	...	...	½— ¾	½— ¾	...	...
9,600*l*	Greenwood & Batley, 7 % Cum. Pref., 1 to 9,600 ...	10	7 %	7 %	...	10 — 12	10 — 12	...	...
15,000	Henley's (W. T.) Telegraph Works, Ord.	10	10 %	12 %	14 %	23½— 24½	24 — 25	24½	24
3,000	Do. do. do. 7 % Pref.	10	7 %	7 %	7 %	18 — 20	18 — 20	...	...
50,000	Do. do. do. 4½ Mort. Deb. Stock...	Stock	4½%	4½%	...	112 —115	112 —115	...	...
50,000	India-Rubber, Gutta-Percha and Telegraph Works ...	10	10 %	10 %	10 %	21½— 22½	21½— 22½	22	21⅝
300,000	Do. do. do. 4 % 1st Mort. Debs.	100	...	...	...	101 —105	101 —105	...	...
37,500	†Liverpool Overhead Railway, Ord.	10	2½%	3½%	3½%	10⅜—10⅝	10 — 10½	...	...
10,000	† Do. do. Pref., £10 paid	10	5 %	5 %	5 %	14⅜— 14⅝	14⅜— 14⅝	...	...
37,350	Telegraph Construction and Maintenance	12	15 %	15 %	15 %	34 — 38	34 — 38	38	35½
150,000	Do. 4 % Deb. Rds. Nos. 1 to 1,500 Red. 1909 ...	100	...	...	...	105 —108	105 —108	...	...
13,400	Telegraph Manufacturing, Ord. Nos. 6,601 to 20,000 ...	5	...	...	...	9¾— 10¼	9¾— 10¼	9 9/16	...
13,400	Do. do. 5% Cm. Prf. Nos. 6,601 to 20,000	5	...	...	...	5¾— 6¼	5¾— 6¼	...	...
540,000*l*	Waterloo and City Railway, Ord. Stock	100	...	...	3 %	109 —112	109 —112	...	...

† Quotations on Liverpool Stock Exchange.
‡ Unless otherwise stated all shares are fully paid.
Dividends marked § are for a year consisting of the latter part of one year and the first part of the next.

LATEST PROCURABLE QUOTATIONS OF SECURITIES NOT OFFICIALLY QUOTED.

*Birmingham Electric Supply, Ordinary £5 (fully paid) 10⅛.
British Aluminium, Ordinary, 10—11; 7 % Pref., 11—12.
House-to-House, 4½% Debentures of £100, 105—108.
Kensington and Knightsbridge Electric Lighting, Ordinary Shares £5 (fully paid) 13—13½; 1st Preference Cumulative 6%, £5 (fully paid), 7½—8. Debentures, 107—110. Dividend, 1898, on Ordinary Shares 10%.
National Electric Free Wiring, 10s. paid, ⅜—½.
Smithfield Market Electric, 3—4.
*T. Parker, £10 (fully paid), 16.

* From Birmingham Share List.

Bank rate of discount 3 per cent. (February 2nd, 1899).

MARKET QUOTATIONS, Wednesday, May 3rd.

CHEMICALS, &c.	This week.	Last week.	Increase or Decrease.
a Acid, Hydrochloric .. .. per cwt.	5/-	5/-	..
a „ Nitric .. .. .. per cwt.	22/-	22/-	..
a „ Oxalic .. .. .. per cwt.	32/-	32/-	..
a „ Sulphuric .. .. .. per cwt.	5/6	5/6	..
a Ammoniac, Sal .. .. .. per cwt.	37/-	37/-	..
a Ammonia, Muriate (crystal) .. per ton	£26	£26	..
a „ „ .. .. per ton	£24	£24	..
a Bleaching powder .. .. per ton	£5 15	£5 15	..
a Bisulphide of Carbon .. .. per ton	£15	£15	..
a Borax .. .. .. per ton	£16 10	£16 10	..
a Benzole (90 %) .. .. .. per gal.	7/-	7/-	..
a „ (50/90 %) .. .. per gal.	5/6	5/6	..
a Copper Sulphate .. .. .. per ton	£26 10	£25 10	£1 inc.
a Lead, Nitrate .. .. .. per ton	£23 10	£23 10	..
a „ White Sugar .. .. .. per ton	£30 10	£30 10	..
a „ Peroxide .. .. .. per ton	£27 10	£27 10	..
a Methylated Spirit .. .. per gal.	2/9	2/9	..
a Naphtha, Solvent (90 % at 160° C.) .. .. per gal.	5/6	5/6	..
a Potash, Bichromate, in casks.. per lb.	8¾d.	8¾d.	..
a „ Caustic (75/80 %) .. per ton	£24	£24	..
a „ Bisulphate .. .. per ton	£35	£35	..
a Shellac .. .. per cwt.	68/-	68/-	..
a Sulphate of Magnesia .. .. per ton	£4 10	£4 10	..
a Sulphur, Sublimed Flowers .. per ton	£6 15	£6 15	..
a „ Recovered .. .. per ton	£5 15	£5 15	..
a „ Lump .. .. .. per ton	£5 5	£5 5	..
a Soda, Caustic (white 70 %) .. per ton	£7 10	£7 10	..
a „ Crystals .. .. .. per ton	£3	£3	..
a „ Bichromate, casks .. per lb.	3d.	3d.	..
METALS, &c.			
b Aluminium Wire, in ton lots .. per ton	£234	£234	..
b „ Sheet, in ton lots.. per ton	£191	£191	..
p Babbitt's metal ingots .. .. per ton	£55 to £130	£55 to £130	..
c Brass (rolled metal 2" to 12") basis per lb.	8¼d.	8¼d.	..
c „ Tube (brazed) .. .. per lb.	10⅝d.	10⅝d.	..
c „ Wire, basis .. .. per lb.	8¼d.	8¼d.	..

Quotations supplied by
a Messrs. G. Boor & Co.
b The British Aluminium Company, Ltd.
c Messrs. Thos. Bolton & Sons.
d
e

METALS, &c. (*continued*).	This week.	Last week.	Increase or Decrease.
f Ebonite Rod .. .. .. per lb.	3/-	3/-	..
f „ Sheet .. .. .. per lb.	5/-	5/-	..
g Copper Bars .. .. .. per ton	£80	£80	..
g „ Wire (basis price) .. per lb.	10½d.	10½d.	..
g „ Sheet .. .. .. per ton	£80	£80	..
g „ Rod .. .. .. per ton	£80	£80	..
n German Silver Wire .. .. per lb.	1/6	1/6	..
h Gutta-percha, fine .. .. per lb.	6/-	6/-	..
h India-rubber, Para fine .. per lb.	4/3	4/3	..
i Iron, Charcoal Sheets .. .. per ton	£18	£18	..
i „ Pig (Cleveland warrants) per ton	54/3	51/2	3/1 inc.
i „ Forgings, according to size per ton	From £11	From £11	..
i „ Scrap, heavy .. per ton	50/- to 55/-	50/- to 55/-	..
i „ Wire galvanised No. 8 .. per ton	£9 15	£9 12 6	2/6 inc.
g Lead, English Ingots .. .. per ton	£14 12 6	£14 12 6	..
g „ „ Sheet .. .. per ton	£15 10	£15 12 6	2/6 dec.
l Mica (uncut slabs 8" long) .. per lb.	6/6	6/6	..
m Manganin Wire No. 28.. .. per lb.	8/-	8/-	..
g Mercury .. .. per bottle	£8 5	£8 5	..
p Phosphor Bronze, plain castings per lb.	1/- to 1/4	1/- to 1/4	..
p „ rolled bars & rods per lb.	1/- to 1/4	1/- to 1/4	..
p „ r'l'd strip & sheet per lb.	From 1/2	From 1/2	..
o Platinum .. .. per oz.	£3 10	£3 10	..
p Silicium Bronze Wire .. .. per lb.	10d. to 1/1	10d. to 1/1	..
i Steel, Magnet, acc'd'g to desc'p'n p. ton	From £15½	to £40	..
i Steel, Magnet, in bars	£58	£58	..
g Tin, block .. .. per ton	£115	£115	..
g „ foil .. .. per lb.	1/6	1/6	..
n „ wire Nos. 1 to 16 .. .. per lb.	1/7	1/6	1d. inc.
p White Anti-friction Metals—			
"White Ant" brand .. per ton	£40 to £65	£40 to £65	..
j Yarns, Cotton, Single 10lb. bundles pr lb.	7½d.	7½d.	..
j „ Flax, 6 or 8 lea... .. per lb.	4d.	4d.	..
j „ Hemp, 3 ply 10 lbs. .. per lb.	3½d.	3½d.	..
j „ „ Russian, 10 lbs. per lb.	4½d.	4½d.	..
j „ Jute, 150 lbs. rove .. per ton	£12	£12	..
j „ Manila, 24 thread .. per ton	£34 10	£34 10	..
k Zinc, Sheet (Vielle Montagne bnd.) p.t.	£31 10	£31	10s. inc.

Quotations supplied by
f The India-Rubber, Gutta-Percha, and Telegraph Works Company, Ltd.
g Messrs. James & Shakspeare.
h Messrs. Jackson & Till.
i Messrs. Bolling & Lowe.
j Messrs. Henry C. Yeo & Co.

Quotations supplied by
k Messrs. Morris Ashby, Limited.
l Messrs. Sanders, Wake & Co.
m Messrs. W. T. Glover & Co., Ltd.
n Messrs. P. Ormiston & Sons.
o Messrs. Johnson, Matthey & Co., Ltd.
p The Phosphor Bronze Company, Ltd.

INSTITUTION OF ELECTRICAL ENGINEERS.

"Capacity Measurements of Long Submarine Cables." By J. Elton Young, Member. Read April 27th, 1899.

The following paper has been prepared both as a *résumé* of researches in a problem which, when pushed to definement, possesses some intricacy, so that others may be saved the labour of repeating them; as well as with the object of submitting to the Institution of Electrical Engineers some conclusions reached with reference to one or two outstanding questions in the domain of electrical measurements of submarine cables.

If progress in this department were gauged merely by the results appearing in the *Proceedings*, it would be very poorly and unfairly represented. For example, with the exception of a very brief but important communication from Mr. J. Gott (Vol. x., page 278), not a single paper bearing on the present subject of capacity measurement is to be found in the Journals since Lord Kelvin's classical contribution to their first volume. But, although frequently unpublished, a great deal of patient advance has been made of recent years in perfecting the testing of submarine cables, all leading to increased accuracy in the localisation of faults.

Of the various investigations which have thus been followed up, with a view to eliminating every residual source of error, none has presented a more curiously persistent elusiveness than the *exact* determination of the electrostatic inductive capacity of a long cable, though its approximate measurement has been fairly easy. There are four factors which have contributed to this want of finality, viz.:—

1. Insufficient definition of the quantity sought for, which is, in fact, a function of the time of charge.

2. Difference between rates of electric absorption of the cable and the balancing condensers.

3. Variations of absorption of both cable and condensers with time of charge and with temperatures involving virtual variations of their capacities.

4. Leakage error, which on long submarine cables is often large, and affects measurements more than any other cause.

With respect to definition of electrostatic capacity, two remarkable results of mathematical theory may be quoted from a paper by Dr. John Hopkinson and Prof. E. Wilson (*Phil. Trans.*, Vol. 189, pp. 109—136), though probably they are also to be found elsewhere. In this they demonstrate that, calling Y the *total* quantity of electricity coming out of a condenser which has been charged for time T to potential X, and writing w for the symbol of variable time,

$$Y = X \int_0^T \psi(w)\, dw,$$

or the capacity is a function of the time of charge, increasing as the time increases. The other result is that the time-integral of current, or the electric displacement, through a condenser, can be expressed in the form:

$$y_t = K x_t + \int_0^\infty x_{t-w} \{\psi(w) + \beta\}\, dw,$$

where the first term represents "instantaneous" capacity, the second residual charge or absorption, and the third conductivity of dielectric separated for convenience, but really all parts of a continuous magnitude.

What the latter formula indicates, with this addition, that in a cable we have retardation of charge by conductor resistance, may be exhibited diagramatically, I believe, as in fig. 1, which illustrates

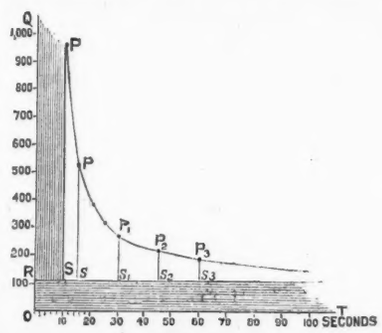


Fig. 1.

what happens when a long cable, with its distant end insulated, is charged continuously. The horizontal shading shows constant leakage current to earth; the vertical shading, P Q R S, represents a portion of the charge that has entered the cable during a period of battery contact of 10 seconds, p P S s the quantity added to it after 15 seconds have elapsed; whilst after 30, 45 and 60 seconds respectively, small additional increments $p\ s\ s\ p$, &c., have flowed into the cable.

This takes place by virtue of the well-known phenomenon of absorption, or residual charge, which commences *at the same instant* as the true or surface charge (as it may be termed), and continues long after the latter has ceased, disappearing logarithmically with the prolongation of battery contact, and leaving the true leakage current O R on which it was superimposed.

Thus the surface charge of the conductor and the residual charge due to dielectric absorption form parts of one continuous magnitude, varying with time, which must be regarded as the capacity of the cable, though theory divides the two. The same is true of any condenser (except one having a dielectric of air, the absorption of which is negligible. If a paraffin-mica condenser be measured by an air standard its value may be raised some 5 per cent. by prolonging the time of charge.

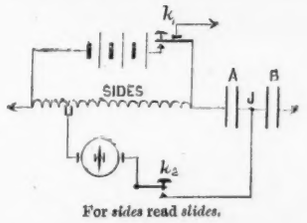
Now, in balancing a cable against a paraffin condenser, if they both have the same rate of absorption there will be no apparent variation of results with the time of charging. This, however, is not the case in general, for not only do the specific absorptive capacities of paraffin and gutta-percha differ, but the conductor resistance of a long cable greatly modifies its rate of absorption, at all events near the beginning of charge or discharge. Thus there will be a divergence of results with different times of charge—quite independently of that due to true leakage effects. (I am assuming that comparisons are made by the usual "Thomson" or "Gott" methods.) This is sufficiently illustrated by the appended tests of two long ocean cables, where due correction was made for the leakage in the manner described further on. See Tables.

Besides this effect of time, there is, moreover, one of temperature to be noticed. The absorptive capacity of both gutta-percha and paraffin is augmented by fall of temperature, thus causing an increase in their apparent capacities. This variation is of a smaller order of magnitude than the former, being, in fact, the increment of an increment. Thus in the case of paraffin the temperature effect is to increase the capacity by only 0·025 per cent. per fall of 1° C. The rate at which it affects that of gutta-percha, whilst in the same direction, is still smaller, and has eluded determination altogether hitherto. Still, it cannot be regarded as negligible when we are seeking the maximum accuracy attainable, and dealing with cables of many hundreds of microfarads submerged at depths such that their temperature falls by some 2° C. below the standard 24° C. of the factories. In the case of ordinary paraffin condensers when employed for accurate measurement it is a factor requiring careful allowance to be made for it; though in the compensated standards constructed by Dr. Muirhead, partly of paraffin and partly of shellac, the opposite behaviour of the shellac neutralises their temperature variation.

There appears to be no *secular* change in the capacity of paraffin condensers when moisture and air have been expelled by heat during manufacture. An apparent secular change has, however, been encountered in the capacity of certain G.P. core, the origin of which deserves to be known amongst telegraph engineers, as it may occasionally explain otherwise anomalous measurements. This was traced to the absorption of water by the G.P. after it had been rendered porous by alternations of wetness and dryness. Water has the highest specific I.C. known of any substance (I believe), and samples of G.P. containing low and high percentages of water have been found to show marked differences of inductive capacity, those with the higher percentage having the larger I.C.* This circumstance somewhat further obscures the search for a coefficient of temperature variation.

Leaving aside the subject of temperature corrections, which are to be made by means of proper coefficients, I pass on to the methods proposed for the elimination of the discrepancies and indefiniteness introduced into comparisons of long cables with condensers by reason of their difference of rates of absorption. For this purpose Dr. Muirhead has given us his correction of Gott's test, applicable perfectly to comparisons of condensers with one another or with short sections of cable, but of little or no use on very long ones, presumably on account of their C.R. retardation. This has often been described, and consists essentially in (1) raising the potential of the junction, J (fig. 2), of the two condensers from zero to a value, v, by application of the charge "in cascade" (by Gott's connections), and then permitting absorption to proceed whilst balance is being found on the slides, which changes v to v_1 by the time balance has been arrived at; (2) lowering the potential of J, by earthing k_1, from v_1 to $(v_1 - v)$; (3) observing the amount $(v_1 - v)$ of this residual potential, and evaluating its effect on the slide reading.

By means of such a correction, if A (fig. 2) be an air standard, and B a condenser of paraffin or other dielectric having absorption, whilst



For *sides* read *slides*.

Fig. 2.

A has *none*, we can arrive at a value of B which is independent of the time of charging, and may be regarded as its constant capacity, eliminating a certain variable part due to absorption.

Now if B, substituted for A, be balanced against a want of core, C, substituted for B, and the same method of correction applied, we similarly get a value for C, in terms of the above constant value of B, practically independent of time of charges which may be taken as the constant capacity of C. So that for a laboratory or factory determination of the I.C. of a condenser or a cable core this plan

* Dr. Obach, "Cantor Lectures on Gutta-Percha," p. 64.

ought to, and does in short, leave nothing to be desired for the elimination of difference of rates of absorption and the establishment of the constant value of the capacity.

When, however, we come to measurements of 1,000 or 2,000 nauts of cable, Dr. Muirhead's method ceases to yield correct results, apparently on account of the extra retardation of discharge by the resistance of the conductor. Abandoning it therefore, we have, when using either the Gott or Thomson balances, values of the I.C. of the cable varying more or less with the time of charge (apart from leakage effect), and are led to seek some other means of getting at our constant or *quasi*-constant capacity. Dr. Muirhead has suggested for consideration that we should take the *varying values of the condenser*, determined by reference to his air standard when absorption is *not* eliminated, and use these for the different times of charging employed on different cables. This would give us the total increment due to the absorption of the cable, in place of the difference of the cable and condenser increments, and thus cause the results of tests by the usual Gott or Thomson methods to rise with time more rapidly than they otherwise do, though more consistently.

A more satisfactory solution of the difficulty has been arrived at, which I will describe presently. Before doing so, however, it is necessary to deal with the important factor of leakage.

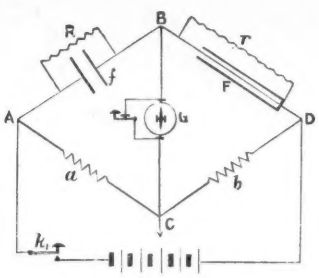


Fig. 3.

Referring to fig. 1, we see that, as distinction has been made between the surface or "instantaneous," and the absorbed or residual charges, so the ultimate conductivity of the dielectric (shown in the diagram by the horizontally shaded area) may be treated as a separate factor in the problem under consideration.

Without entering into a description of the three well-known methods of I.C. measurements applicable to long submarine cables, viz, the Siemens fall of charge, the Thomson parallel charge, and the Gott "cascade" charge, let us examine the effect, upon the capacities under comparison, of their respective insulation resistances in the two latter methods. In Siemens's there is, of course, no leakage error, because the D.R. enters into the formula, an advantage which

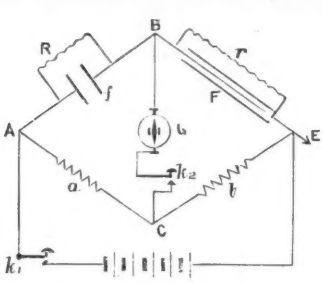


Fig. 4.

would place this test above the others beyond dispute, were it not that it is incorrect for other reasons. Leakage on the *battery*, a matter of vital importance in the Thomson method—though not so in Gott's—we may assume to be absent, but it must on no account be forgotten when joining up for the former test. Its vitiating influence on results has indeed been one of the chief reasons for preferring Gott's method.

Both the Thomson and Gott are null methods, or balances, differing essentially in the circumstance that in the former the two capacities are charged in parallel, and in the latter in series or "cascade." For the purpose of investigating the leakage error the diagrams of connections may be conveniently drawn as a bridge system. See figs. 3 and 4, which represent the conditions during charging, f being the condenser capacity, F that of the cable, R and r their respective insulation resistances.

In fig. 4 balance is observed by closing k_2 without discharging. In fig. 3 it is observed after mixing the charges, by an arrangement of keys not shown; but it will be found that for the determination of the leakage error it is practically sufficient to examine the conditions during charging only.

(To be continued.)

Sunderland.—A report just issued shows that, after providing for sinking fund and interest, a profit of over £300 has been made by the Corporation on the past year's working of the electric light undertaking.

ELECTRICAL FEATURES AT THE BUILDING TRADES' EXHIBITION.

The exhibits of an electrical character at the Building Trades' Exhibition at the Royal Agricultural Hall are increasing year by year, such increase running more or less in parallel with the inroads which electricity is making into residential and business buildings. The electric lighting exhibits have shown the most marked advance, and this has led to the introduction this year of a special "Electrical Appliances" section, where there is quite a respectable showing. The newest feature is certainly the electric tramway exhibits in connection with the *Surveyor* road-making section in the gallery. By the time the Exhibition closes to-morrow (Saturday) the two electric traction stands, those of Messrs R. W. Blackwell and Co. and Messrs. Laing, Wharton & Down, will doubtless have been visited by surveyors and other municipal officials from various parts of the country. And no doubt many a Councillor or Vestryman will have a wider knowledge of electric traction matters, after spending a little time at one or both of these very interesting stands. Messrs. Blackwell exhibit, among other things, several models of Peckham trucks as used on the Leeds, Stockton and Bradford lines, the Vandorn automatic coupling, such as they are supplying for Glasgow and other places, the Boston pivot trolley, the Weston standard measuring instruments, the Falk rail joint, and the Hyatt roller bearing. We also noticed the "Packard" incandescent lamp, which is now being introduced into this country by Messrs. Blackwell. For this lamp it is claimed that it only burns 3·5 watts per C.P., and will not blacken. This firm also shows a good deal of insulating and line material, and the Syracuse changeable electric head light. This latter consists of a polished aluminium reflector with a glass front. A contact stem, with brass contact plates set in it, has wires running from these plates through the centre of the stem to the lamp socket at the top. Inside the receptacles at each end of the car are brass spring connections, these receptacles being connected with the car lighting circuit. The brass spring connections in the receptacle both hold the head light firmly in place and complete the circuit, lighting the lamp without the aid of a switch. The driver lifts the lamp out for changing to the other end of the car with great ease. It is claimed that such head lights cost considerably less for current than any other method.

Messrs. Laing, Wharton & Down have on view a variety of the "Whardown" track tools for use in the construction and repair of electric tramway tracks, the "Paulus" and "Buda" track drills, which are being used by a large number of English tramway companies and corporations now engaged in electric tramway equipment. In connection with the Manchester trams, as many as eleven of these drills are being used. With these automatic feed drills it is possible for the operator to stand erect whilst drilling bolt, tie and bond holes. The "Paulus" drill is for ordinary work, and the "Buda" for heavy and deep rails. Another speciality shown at this stand is the portable rail saw for cutting off rails true to length, with square ends or at an angle and with great accuracy, on the track. The jaws are adjustable to fit varying rail sections. The saw is driven from its periphery and not by the spindle, thus securing extra power and less wear on the spindle. The saw is hollow-ground and acts like a continuous planing machine. It is claimed that by the use of this saw considerable economy in both time and labour is effected as compared with the ordinary method. The "Pearson" lifting jack is an important accessory for any line. It is intended for taking off and replacing rolling stock. Each end of the jack is provided with a movable non-slipping head, by means of which the strain is equalised on the jack, no matter what angle it is working at, and equal power and facility in use is obtained. The armalac and enamelac insulating compounds used for all electrical purposes in many parts of this country, and the G. E. cement, okonite wires and cables and okonite tape, Forest City protected rail bonds, and the roll drop forgings are among Messrs. Laing, Wharton and Down's exhibits. We also noticed a fire station lighting switch, such as they are making for the London County Council to switch on the lights in a fire station when an alarm rings; the Garton lightning arrester, and a switch for the Glasgow lighting installation for cutting out one of the feeders.

Gas engine makers are, as usual, here in full force, the "Stockport," National, Hindley, Blackstone, Scholefield, and other makes being exhibited by their various manufacturers. Wood-working machinery is shown by Messrs. J. Sagar & Co., Messrs. Kirchner & Co., and Messrs. R. Becker & Co., and Messrs. W. Hardill, Sons & Co.

Smoke prevention appliances are supposed to be a special feature of this exhibition. We noticed a few exhibits of this character, but chiefly for private house use. The Hon. Rollo Russell has been lecturing on the smoke question under the auspices of the Smoke Abatement Society.

Messrs. Doulton & Co. make, as usual, a good showing of their many lines of Doulton ware manufactures. Messrs. Mathews and Yates exhibit the "Cyclone" electrically driven fans, and the Blackman Ventilating Company, Limited, have on view a number of their electric fans and other specialities, for drying and ventilation purposes.

We cannot afford space for anything more than a very brief reference to the electric lighting and accessories exhibits.

In the special Electrical Appliances Section, if fortunate enough to find it, one is struck by the absence of din and noise. On the occasion of our visit it certainly was not besieged with visitors, but doubtless such is the exception rather than the rule. While it is only right that so important a class as electrical goods should have a section specially devoted to them; it should hardly have been poked away in a corner called the "Minor" Hall. There is nothing in this section in the way of heavy electrical machinery; it is con-

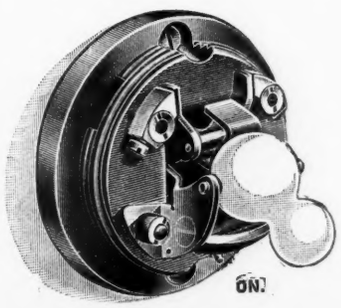
fined mainly to electric lighting and heating fittings, and accessorial parts.

The Jandus Arc Lamp Company have a good showing of the Jandus lamps; the Simplex Steel Conduit Company have a large selection of their electric lighting conduits and fittings, the stand being wired on this system. Messrs. Foxcroft & Duncan, of Dalston, show the "Sappho" enclosed arc lamp and various ammeters, voltmeters, and other measuring instruments. The Simplex Engineering Works have a display of electric alarm clocks, and dynamo and motor rheostats, &c.; Messrs. W. R. Webb & Son, electric bells and telephones and accessories. Messrs. Julius Sax & Co. have an excellent stall, where we observed their electric water-gauge tank alarms, and a variety of their electric bells, indicators, and other manufactures. A noteworthy feature at Messrs. Sax's is the "Eagle" arc lamp. In this lamp, of which several are shown, every effort has been made to simplify the construction of the feeding and striking mechanisms, and it is claimed to work equally well for either direct or alternating current. Messrs. F. W. Potter & Co. show the Wing electric fans, and "Soar's Dovetail" dynamo brushes. Mr. J. M. Doughty has a tastily-arranged exhibit of many kinds and designs of electric light fittings, including electroliers, brackets, bronze figures, &c. Messrs. W. J. Bishop & Co. exhibit telephones and small fittings. Messrs. Johnson & Phillips show cables and wires for various electrical purposes. An exceedingly interesting stand is that of the Dowsing Radiant Heat Company. Here there are shown fitted to a drawing room fire-place the radiators recently described in our columns. Among the most striking stands is that of the Edison & Swan Company. The many designs of fittings which this company manufacture in such charming variety are here displayed to great advantage. The general arrangement of a host of electroliers, brackets, standards, bronze statuary, interspersed with a number of brilliant arc and Queen incandescent lamps, also the Stewart Lilliputian arc lamp (which gave a very soft and pleasing light) all combine to make the stall representative of so well known a firm as the Ediswan Company. The Ediswan new motor, described in the ELECTRICAL REVIEW a few weeks ago, is shown, also the company's alternating current motor with clutch pulley, a stage arc lamp, and measuring instruments, &c. The great thing claimed for the Ediswan stand is that everything was made at Ponder's End.

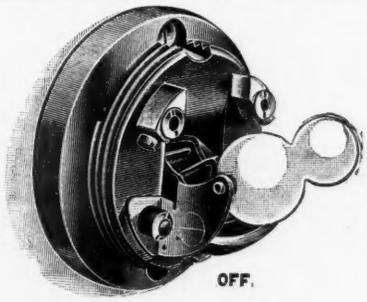
Among other exhibitors is Mr. H. Newman Wilkinson who has on exhibition a number of improved glow lamps, but the great catch at this stall is undoubtedly "Anti-splash." Perhaps we had better remark that this is *not* an electrical accessory, but a most convenient little socket arrangement made of Excel silver for slipping on to water taps for the purpose of avoiding splashing. We have been told that the refreshment bar at the Hall possesses more attractions than any of the temporary exhibits, but in "Anti-splash" it has found its rival.

SOME NEW HIGH VOLTAGE FITTINGS.

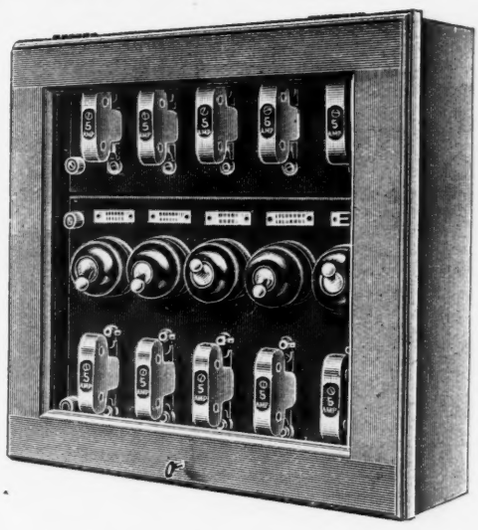
THE adoption of 200 to 230-volt lamps for private lighting has been pretty general, both where plants have been worked by municipalities



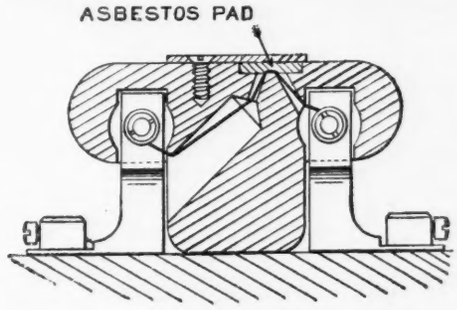
and where companies have been the controlling authorities. It is matter of history that many towns converted their systems from low



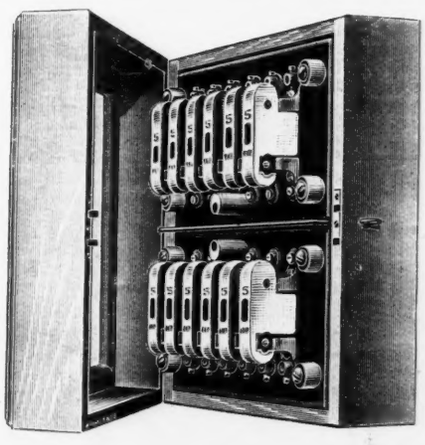
voltage supply to high tension at considerable cost, with a view to effecting economy in the direction of mains expenditure and realising certain other advantages. Fittings manufacturers have not been slow to fall in with the new state of things, and numerous lamps and accessorial parts for use with higher voltage are now upon the market. Messrs. Dorman & Smith are among those who have remodelled their accessories to meet the altered conditions. They are now introducing some new specialities, of which we give a few brief notes and some illustrations. We refer to the D. & S. new patent porcelain switches and fuse bridges suitable for 250-volt circuits.



The switch illustrated is constructed entirely of porcelain and metal without the use of fibre or other semi-insulator. Even the handle, which is of the favourite lever type, is made of porcelain in order to avoid any possibility of dangerous shocks being transmitted to the user. The switch has a very quick and long break, independent of the speed at which the handle is turned, and also a very large



amount of clearance between the terminals and other metal parts when in the "off" position. The extraordinary way in which the contact maker disappears from sight when the switch is turned off is



most fascinating. We understand that every detail of the switch has been carefully worked out in order that the utmost strength and durability may be attained.

The principle on which the new fuse bridge is constructed will be

obvious from an inspection of the sectional view. It will be seen that a solid wall of porcelain is interposed between the terminals of the fuse, rendering the formation of a permanent arc between them impossible. The fuse wire at one point is held between the face of the porcelain and an asbestos pad or damper. Past this point it is impossible for the arc to strike. The bridges are claimed to be instantaneous in action, very strong, and capable of being very easily re-wired. It is stated that a great advantage of these bridges is that they are perfectly efficient, even when made with a short clearance between the terminals, and packed as closely together as possible. The distributing boxes can consequently safely be made as neat and compact as was the case with bridges suitable for 100 volts.

LONDON COUNTY COUNCIL.

The Council, on resuming business last week for the first time since the Easter recess, decided to lend £4,820 to the Hammersmith Vestry for electric lighting purposes, and £8,540 to the Battersea Vestry for the purchase of land for the extension of the electric lighting station.

Electric Traction and Diversion of Mains.

It may be remembered that in February last the Council decided to ask the Board of Trade to insert in each of the provisional orders which may be granted in the present session a special clause stipulating that the electric light mains sanctioned under these orders should not be placed in such positions in the streets as, in the event of the Council adopting some form of electric traction on the tramways, would necessitate the removal of the mains to other positions. A similar request was made by the Council in two previous years, but the Board of Trade pointed out that a joint committee of both Houses three or four years ago had fully considered the question, and had settled a clause to be inserted in all Bills and provisional orders authorising the use of electricity on tramways, and that that clause would apply if the Council were authorised to introduce electric traction. This reply did not satisfy the Highways Committee, who then obtained the consent of the Council to the Board of Trade being approached by Earl Russell on the subject of the Council's special clause being included in the orders of the present session.

In reporting upon this question the Highways Committee now stated that the Board of Trade had intimated that they had given the matter careful consideration, but that having regard to the provisions of Section 15 of the Electric Lighting Act, 1892, they were unable to insert in the orders the special clause asked for by the Council. The Board further expressed the opinion that full protection is afforded to the Council by the provisions of the Act above referred to and of the various orders, under which the Council would have power, subject to certain conditions, to alter the position of electric lines and works of undertakers, which would interfere with the lawful exercise of any powers vested in the Council in respect of its tramways. In commenting upon this result the Highways Committee stated that "the decision of the Board is to be regretted, but we do not see that anything further can be done with regard to the matter."

Provisional Orders.

The Highways Committee reported that the Board of Trade had granted the orders applied for by the Vestries of Bermondsey, Plumstead, and Bethnal Green, and had given effect to most of the suggestions made by the Council in regard to those orders. The Board had, however, not adopted the Council's suggestion that the standard price per unit should be reduced from 8d. to 6d. in each of the orders. The Council had also asked that the supply of energy under the Plumstead and Bethnal Green orders should be by continuous current; but the Board of Trade stated that this provision was not inserted except in orders relating to districts in respect of which powers had previously been granted to other undertakers, and that the Board could, therefore, not agree to the provision being included in those orders. With regard to Bermondsey, the order embodied a provision that the system of supply shall be by continuous current.

With respect to the Blackheath and Greenwich District (Extension) Order, the Highways Committee stated that the Board of Trade had not adopted the Council's suggestions to reduce the maximum charge per unit and to sanction the supply by continuous current. The committee mentioned that in an order granted in 1897 in respect of a district coterminous with that which is the subject of the present application by the same company, provision was made for the supply to be by continuous current, and they had, therefore, asked the Board of Trade to reconsider the decision arrived at in regard to the matter.

New Central Station.

According to a report by the Building Act Committee, the approval of the Council had, during the recess, been given to a plan submitted by the City of London Electric Lighting Company for the construction of a furnace flue to the western chimney shaft at the Bankside station.

It was decided to approve plans presented by Mr. O. E. Winter on behalf of the Poplar Board of Works for the erection of an electric lighting station in Glaucus and Yeo Streets, Bromley.

At the meeting on Tuesday this week the Bridges Committee recommended the Council to give permission to the National Telephone Company to lay three mains in the southern pathway of Bow Bridge, on the company agreeing to pay an annual rent of £5 for each main for the easement.

The Tramways Bill.

A reference to the Electrical Review of April 21st, under the heading of Lambeth, will remind readers of the attempt made by the County Council, and its discovery, by accident, by the Lambeth Vestry and the Wandsworth Board of Works, to supersede these two bodies as the road authorities in the scheme for adopting electric traction on the Council's tramways. The Council sought leave to obtain a suspension of standing orders to introduce a Bill to authorise the conduit, trolley, or surface contact system, but quite innocently refrained from acquainting the two authorities in question of the intention to apply to bring in the Bill.

The Highways Committee now reported that the application was opposed by the Lambeth Vestry and the Wandsworth Board of Works, and that the Standing Orders Committee decided not to suspend the standing orders so as to permit of the Bill being proceeded with. It would have been better for the Highways Committee to have been candid with Lambeth and Wandsworth from the onset.

THE THEORY OF WIRELESS TELEGRAPHY.

An interesting contribution to the theory of the vertical conductor appears in the *Comptes Rendus de l'Association Francais pour l'Advancement des Sciences*, in a communication made to the said Association at Nantes last year by M. Blondel, "Sur la Theorie des Antennes dans la Télégraphie Sans Fil."

M. Blondel remarks that it is no longer possible to look upon wireless telegraphy as Hertzian waves radiating from the spark gap of the transmitter, since Marconi has shown that the range is so enormously increased by the use of "antennæ" (the name which he applies to the vertical conductors) with earth connections. It is necessary, then, to attribute the principal effect to an oscillating system, in which the capacity of the transmitting antenna in relation to the earth comes into play.

This antenna and the earth play the part of the two plates of a condenser, which is charged by the coil and becomes the seat of an oscillating current when the spark passes across the air gap. Owing to its position lines of force radiate like a fan in all planes, from the antenna to the earth. The displacement currents, produced by the oscillating E.M.Fs. along the lines of force, are consequently concentrated in a limited space around the antenna, but the Hertzian waves produced by them around the antenna spread straight out into space. The oscillations in the wire are not themselves utilised, but they give birth to those which are utilised by causing a disturbance in the surrounding ether. The direct radiation from the antenna and the earth is very intense, but is quickly damped out, and that in Blondel's opinion is the reason why it has hitherto been found impossible to establish resonance between the transmitting and receiving antennæ.

The important *rôle* played by the capacity of the antennæ appears to be supported by the following experimentally-ascertained facts:—1. The range attained when the antenna is not connected to the earth is comparatively insignificant. 2. The range depends upon the height of the antenna and not upon the oscillator. 3. The character of the spark changes when the oscillator is put to earth; from being long and slender, it becomes short and thick.

It would appear, therefore, that the capacity of the antenna will determine the length of the waves; the latter is sufficiently great relatively to the height of the antenna, as to make it admissible to assume as a first approximation that the oscillating electric current along the conductor is sensibly the same as in the wings of a Hertzian oscillator.

This being granted, it is easy to see that the *rôle* of the transmitting antenna is twofold:—

1. In the first place, it regulates the intensity of the centre of disturbance by augmenting the volume of ether disturbed by the oscillator. In fact, the lines force, being displaced with the same rapidity in the air and along the wires, and abutting always normally on the conductors, according to the known properties of electric oscillations, ought to have the form of hemispherical sheets, diverging from different points of the antenna and abutting normally on the ground. At each discharge they stir up the surrounding ether like the pulsating hemispheres of Bjerkness. The higher the antenna, the greater is the pulsating sphere, the greater is the volume of ether disturbed, and the greater

is the distance at which the disturbance is perceptible. It may, therefore, be asserted that the antenna determines the volume of disturbance at the transmitting station.

2. In the second place, the antenna directs the magnetic lines of force produced in the direction calculated to produce the maximum effect on the parallel antenna at the receiving station. The magnetic lines of force are horizontal circles concentric with the antenna, and expand horizontally into space till they strike the receiving antenna at right angles, and generate oscillations which affect the coherer at its base. This favourable result is not obtained except the antennæ are parallel.

The antennæ, it is true, may be placed parallel without being vertical; for instance, they may be horizontal, with a spark gap at the centre of the transmitter, and a coherer at the centre of the receiver. The arrangement is then similar to that of Hertz. The volume of disturbance is still determined by the length of the antennæ. But the neighbourhood of the ground introduces a disturbing influence, because the magnetic lines of force, instead of moving parallel to the earth, cut it at right angles during their propagation, and generate currents which involve a considerable loss of energy, and rapidly enfeeble the waves. Vertical antennæ are therefore much to be preferred.

It is easy to reduce this problem to that of the Hertz oscillator. Let us suppose that the earth, which here plays the part of a conductor along which the waves glide normally, is replaced by a thin metal disc of perfect conductivity. Hertzian waves, whatever their form be, will give place to superficial currents in the wire forming the antenna and in the upper surface of the disc. Let us suppose that an image in the disc of the antenna, fitted with an oscillator having a synchronous equal and opposed E.M.F., is set in operation below the disc. It will produce on the lower surface of the disc superficial currents which exactly annul those due to the real antenna. Everything will happen, therefore, as if the disc or the earth did not exist, but only the two opposed antennæ, the combination of which forms exactly a Hertz oscillator. Hence the conclusion that the combination of a transmitting antenna and the earth (supposed to be a perfect conductor) is equivalent to the half of a Hertz exciter of double the length and potential. The same reasoning shows also that the combination of a transmitting antenna and the earth is equivalent to a rectilineal resonator of double the length, in the centre of which a coherer is interpolated.

Following Poincaré in assuming that the current in the antennæ is uniform, and applying the formula of Neumann for the mutual induction of oscillating currents, the current induced in the antenna of the receiver is simply proportional to the coefficient of mutual induction, M, of the two antennæ, and to the variation, di, of the current in the receiving antenna.

The effect produced on the receiver will therefore be of the form $\frac{H H^1}{r} \frac{di}{dt}$ where H and H^1 are the heights of the antennæ and r is their distance apart.

Experiments appear to confirm this approximate law of proportionality to the product of the heights. But it must not be forgotten that an increase in the height of the transmitting antenna increases its capacity, and therefore reduces the frequency of the oscillations, and also the difference of potential at the terminals of the induction coil. The factor $\frac{di}{dt}$ is thus reduced.

The theory is only approximate, and neglects the loss of energy due to the earth being an imperfect conductor. This theory in Blondel's opinion explains why the range of transmission is greater over sea than over land.

STORAGE BATTERIES FOR ELECTRIC RAILWAY POWER STATIONS.

The 460-ton accumulator, described at page 2 of our last volume, has undoubtedly been a most successful feature of the new Chicago-Edison electric lighting and power installation. Not only does the battery carry the peak of the load; it is found most serviceable for maintaining a constant pressure on the system—thus relieving the switchboard attendants at the generating station from constantly watching and regulating the voltage. In regard to the economy effected by its use, Mr. J. Appleton observes: "In a lighting and power station such as this, the maximum load occurs for only a very short period during the year. In one station I know of, 50 per cent. of their investment is for generating plant and underground conductors used only for 154 hours during the year." This statement may seem astonishing, but will be found to apply to many such stations. Where such conditions exist, it will readily be seen how great are the advantages of storage batteries as auxiliaries. Their cost per kilowatt of output for short periods such as these peaks is less than that of the generating machinery "which would have to be provided if they were not used; in addition to which there are other ways in which they prove advantageous in the operation of the plant."

But the use of the storage battery for producing a more equable output of energy, or flattening the loadline of the generating machinery, is extending in other directions besides electric lighting. This is especially the case in America. In a paper recently read before the American Institute of Electrical Engineers, Mr. Robert Mc A. Lloyd strongly advocates the installation of storage batteries in railway power stations. The engineering superintendents of such establishments would appear to be greatly in need of enlightenment. They seldom have any data of value from a commercial point of view in relation to the variations of output at their stations; being, as the author of the paper observes, "usually contented with superficial observations of the switchboard and the comforting fact that the cars are running." They are greatly surprised to find that the maximum load for a given period is far below the nominal capacity of the generating plant in operation. Nor can this always be accounted for by the very natural supposition that the surplus capacity is intended as a reserve to meet emergencies. For in one particular case investigated by Mr. Lloyd, the highest load point reached on the day of heaviest travel in the whole year was within the capacity of the main station, and yet, from the standpoint of the manager, engineers, and attendants, this station was dangerously overloaded and had no reserve, and it was necessary to augment the capacity in order to render it safely operative.

It is tolerably evident that, in this case, either the capabilities of the station machinery had been overrated or the engineer was over cautious, or perhaps incompetent. "But," says Mr. Lloyd, "the fact remains that similar data have been obtained at many stations where the machinery has been subjected to satisfactory tests prior to purchase." The fact also remains that steam machinery should, as far as possible, be worked up to its maximum economical output. Mr. Lloyd admits that it may be possible to build engines which regulate at all conditions of load, and at the same time use steam satisfactorily at maximum load; but, he says: "I do not find such engines commonly in use." He states, moreover, that there are many very good engines in use which cannot be safely worked at anything like maximum load if the load be subject to sudden variations.

Still more to the point are the two following observations of Mr. Lloyd. He says: "Experience convinces me that the men who are most likely to be consulted about such a station will recommend more generating plant"; and "One generally finds that, where there is plenty of apparatus (steam plant) available, the engineer is tempted to keep too much of it running, and therefore running at low efficiency." The storage battery, it would appear, is called upon not only "to take care of the peak" but to fight its way against the pushing representatives of steam plant and dynamo manufacturers—Mr. Lloyd calls them "generator salesmen"—who, it seems, are "the men most likely to be consulted." These energetic gentry naturally endorse the old, and, we should have thought, obsolete, argument that "the best storage is a good steam engine and dynamo in reserve." Their apparatus, they say, is cheap, and it is good to have plenty of it. Through their persuasive powers, not only has the storage battery been neglected, but the generating plant has been augmented in cases where a little attention to details, such as steam piping, would have sufficed to meet the required output.

In illustrating some of the advantages to be derived from the use of storage batteries, Mr. Lloyd takes as a typical case a station located in a Pennsylvania town of 50,000 inhabitants. There are three distinct ways of using a storage battery with the power plant of such stations. The load curves show: (1) the great fluctuation between night and day load; (2) the fluctuations occurring from hour to hour; and (3) the superimposed fluctuations occurring from moment to moment. A battery of sufficient capacity to level off the night and day fluctuations is characterised as "large"; that for levelling the hour-to-hour fluctuations is called "medium"; and that to level the momentary fluctuations "small." Taking in inverse order the duties required of these batteries, the load diagrams of the above station show at a glance that a "small" battery, able to discharge at 650 amperes for momentary periods, but of which the capacity in ampere-hours is unimportant, will allow of the generating plant being reduced to a capacity sufficient to meet the demands of the *average* load. Such a battery will cost less than generating capacity for the work it can do; and it will save a large portion of the excess of capacity over requirements which is exhibited by the load diagram. It will save some depreciation on the generating machinery, and its own depreciation will not cost more than that of apparatus of similar capacity. The battery will have sufficient capacity to run a few night cars and lights when the engines are shut down. If it be located at a point nearer the centre of feeder distribution than the location of the generating station, a saving in copper may be effected. Inasmuch as the investment will not be increased by including such a battery in the railway outfit, all the saving in fuel due to a steadier load and the operation of less generating machinery will be clear gain to the credit of the battery.

The "medium" battery for flattening the average load line for 18 hours of the day would require to have a capacity of 1,300 ampere-hours, and will cost about twice as much as the "small" battery. It will not, however, bring the cost of the installation up to that of the generating machinery now employed, and presumably necessary when no battery is used. This battery will realise all the advantages of the former one, with wider limits of operation. The station circuit breakers may be set 650 amperes higher, and there will be greater convenience throughout the station in operating at a fixed load. There will be a marked effect in the efficiency of all departments of the station; and all the machinery will yield a higher output in proportion to investment and cost of working.

The "large" battery capable of levelling off the average load for 24 hours would have a capacity of 3,000 ampere-hours. It will cost approximately twice as much as the "medium" battery, and will have all its advantages. It will cost as much as the generating machinery displaced by it, but will add largely to what Mr. Lloyd terms the "flexibility" of the station. This battery could be discharged momentarily at 3,000 amperes, which will put the circuit-breaker limit of the station at about 3,600 amperes, instead of 2,300, with all the present apparatus. It may be discharged at 1,500 amperes for one hour, which will be sufficient to cover load peaks that would stall the 1,500 kilowatt generating plant completely.

Mr. Lloyd points out that in cases of extreme necessity, the whole load of the station could be carried by this battery for several hours. An important consideration is that the ability to carry sharp peaks is a distinct addition to the earning power of the system. Such peaks often signify the earning of fares, which would be lost if the system were not rendered so "flexible" by the use of storage batteries. Some managers maintain sufficient capacity to carry a few holiday crowds in the course of the year, whilst for 99 per cent. of the whole year the extra plant is earning nothing. Other managers do not even attempt to carry special crowds. The above-mentioned "large" battery would give managers the means of earning all the money that can be made out of the business, and that without any special investment for the purpose. It must, of course, be borne in mind that the capacity of the system may be limited by the amount of the investment in copper; but, on the other hand, the battery may be so located that it will economise the conducting power of the mains.

We must agree with the author of the paper that there is no valid reason why a railway power station, running night and day at a constant load, should not attain a fuel economy as high as that which is realised at the Chestnut Hill pumping station at Boston, which would be equivalent in electrical work to 557 watt-hours per pound of coal. The battery efficiency in the case of railway power stations has been estimated at 75 per cent.; and it is stated that in some analogous cases it has reached over 90 per cent. The efficiency here referred to must be "quantity efficiency"; and the latter figure would be a record value at that. We must confess that we are sceptical as to "energy efficiencies" above 68 per cent.; although we are aware that they have previously been quoted as high as 76 per cent.

Finally, Mr. Lloyd claims for the storage battery that it would save water, oil, waste, &c., and that it would realise the advantages of more constant potential on the lines, less annoyance from circuit-breakers, and no fear of sudden demands on the generating machinery, and the disagreeable possibilities incident thereto.

ELECTRICAL ENGINEERING STUDENTS "ON TOUR."

Students of applied science in this country are occasionally taken by their professors or teachers over some of the works in the vicinity, where the apparatus and processes they have been studying in class rooms and laboratories can be seen in operation upon an industrial scale.

The Institution of Junior Engineers in London also organises similar expeditions for its members. In neither case, however, do these educational pilgrimages lead the participators very far afield.

The professors of the Ecole Superieure d'Electricité, of Paris, have developed the idea in a manner which we shall expect to see imitated, for in April, 1898, a party of the more advanced students was taken upon an educational tour through Switzerland.

They visited most of the notable electric installations in that country, and in the book named below,* they record their experiences and observations. The members of this party will no doubt look back upon the excursion of 1898 with feelings of considerable gratification, for not only did it lead to a widening of their mental horizon and increase of their knowledge, but one and all have as a result of it blossomed into authors, while still, we suppose, in their teens. In the book under review, there are none of those excrescences of humour or of tall writing—which one might have expected in such a production—and the "notes" are strictly confined to business. We wonder if this result has only been attained by much use of editorial red ink?

Prof. Janet, head of the school, contributes an introduction to the notes in which he explains the choice of Switzerland. The gist of this is contained in the following passage:—

> It is no exaggeration to say that (in Switzerland) in a few days, and within a few hundred kilometres, it is possible to see represented in abridged form the history of the last few years in electrical engineering. The continuous current rejuvenated by the series system of Thury; simple alternating current already out of fashion and destined to disappear; di-phase likewise on the wane and to-day giving place to the tri-phase.

The excursion lasted 9 days, and was participated in by 13 students, who are conjointly responsible for the 10 chapters into which the book is divided.

It will be consoling to English electrical engineering students, ignorant of all languages save their own, to hear that these French students were unable to get along in Switzerland without an interpreter. We do not advise them, however, to persist in their ignorance. Every English student of electrical engineering ought to know German, and his ignorance of that language in these days of keen competition and rivalry is simply inexcusable.

The notes deal with the following:—Hydraulic installations; systems of distribution; electric traction; electrical engineering works; and calcium carbide manufacture.

Chapter I., dealing with hydraulic installations, will be found by many readers the most interesting in the book,

* "Une Excursion Electrotechnique en Suisse." 90 pages. Paris: Gauthier-Villars, 1899. Price 2 francs 75 cents.

since some of the generating stations, which the students visited, have not before been described in print. Fourteen hydraulic power centres were visited and are described; of these the installations at Chevres, Rheinfelden and Zurich are the more notable.

Since the authors were at Chevres, that station has been the scene of a disastrous fire. With regard to the utilisation of water powers of low head in Switzerland, the authors state that when used for lighting purposes, it is customary to run the low-head turbines during the day, and to work pumping machinery by which the water is raised to a high level resevoir; high head turbines are then run from this stored supply when the maximum power of the station is demanded.

In this way the output of a low-head power station can be almost doubled. At Vevey-Montreux both water and steam power are used; at Zurich water-power, both high and low head, and steam power are utilised. At Chevres, the power station which supplies Geneva, only 5 of the 15 1,200-H.P. turbines, for which the station is planned, were installed at the date of the visit. The authors state that the Rheinfelden generating station is designed for 1,700 H.P.; this is an obvious misprint for 17,000 H.P. In this chapter special attention is devoted to the details of the system and apparatus for regulation of the turbines at the different stations, and drawings are given of the more important.

With regard to systems of distribution, two generating stations use continuous current, three use simple alternating current, three use two-phase alternating current, and four use three-phase alternating current. The latest and second largest power station—that at Rheinfelden—distributes by the three-phase system. Chapters II. to VI. are devoted to a description of the details of the distributing systems at these 12 centres.

Chapter IX. gives a few details of the works of Brown, Boveri & Co., and of the Oerlikon Company. Each of these draw a large portion of their power from distant waterfalls by electrical transmission. The works of Thury were also visited by the students, but the visit was too hurried to permit of note-taking.

The carbide works at Langenthal is described in Chapter X. So far as we are aware, the plant at this works has not previously been described in print.

In conclusion, we may state that the notes are well arranged, and that the book is well printed and well illustrated. It lacks a good index, and it is certainly a pity that no reference has been made to the descriptions which have from time to time appeared in the technical papers and magazines of this and other countries, of some of the installations dealt with in this book. For instance, the buildings and machinery at Chevres, Rheinfelden and Zurich have been described by writers in *Cassier's Magazine*, in July, 1895, and June, 1897, and had the authors made use of these contributions, they might have been able to concentrate their observations upon features of these installations which have received little notice.

However, these are minor blemishes, and we can recommend the book to all electrical engineers interested in the development of water-power, and in its applications to the most varied requirements of city and industrial life.

EXPERIMENTS ON THE STERILISATION OF WATER BY OZONE.

By EMILE ANDREOLI.

The sterilisation of drinking water, which is by far the most important application of ozone, can only be effected when the following conditions are fulfilled:—

The yield of ozone must be high and constant.

The apparatus must be such that it can work continuously without heating, getting out of order, or breaking down.

The cost of the purification of water must be as low as possible.

A fortnight ago a report has been published on some experiments carried out at Lille by Dr. Marmier and Prof. Abraham for sterilising water by ozone.

There is nothing new in the ozonisers which they used, as their electrodes consist of hollow boxes, through which water circulates. This was the characteristic feature of an ozoniser which I patented in 1896, the arrangement of which was described in the Electrical Review (April 23rd, 1897, page 564), and everyone will agree with me and say that an installation of high tension ozonisers, complicated with a circulation of water, is not the last word of progress.

This report by Dr. Staes-Brame, Dr. Roux, sub-director of the Institut Pasteur in Paris, Prof. Buisine, Dr. Calmette, and Mr. Bouriez, is remarkable from the bacteriological point of view, and is practically the absolute sanction of this fact that ozone is a most powerful microbicide. If, up to the present, there has been some doubt about the sterilising properties of ozone, they must be dissipated now that we have this report signed by such high authorities, and we extract from its conclusions the following passages:—

"All the pathogenic or saprophyte microbes which exist in the waters which we examined, are absolutely destroyed by one passage of the water through the ozonising columns. A few germs only of the Subtilis bacillus resist.

"With a concentration of 6 milligrammes of ozone per litre of air there is about one germ left in 15 cc. of treated water.

"With a concentration of 9 milligrammes, the number of germs of Subtilis bacillus revivifiable by culture in broth falls down to less than one for 25 cc. of treated water. It is important to note that the Subtilis bacillus (Hay microbe) is quite innocuous for men and animals.

"Besides, the germs of this microbe resist to most of the means of destruction, such as heating by steam under pressure at 110°C.

"Therefore it is useless to require its complete disappearance from drinking water, and we consider as quite sufficient the sterilisation obtained by ozonised air with a concentration of 5 to 6 milligrammes of ozone per litre.

"Ozonisation does not add to the water any foreign element which might impair the health of the people who drink it. On the contrary, waters which have been submitted to the ozone treatment, are less liable to ulterior pollution, owing to the increase of nitrates and the reduction of organic matters, and are therefore less alterable.

"Finally, ozone being nothing less than oxygen in a special molecular state, its use presents this advantage, that the water is strongly aerated, and without losing any of its useful mineral elements, is rendered more healthy and more palatable."

It is regrettable that the doctors of the Institut Pasteur did not mention in their pamphlet the cost of the sterilisation of water per cubic metre (220 gallons). The concentration of 6 milligrammes of ozone per litre of air, of which the report speaks, does not convey any information to our mind as to cost, since we are not told how many litres of air were forced per hour through a mass of water representing a given number of cubic metres.

We have no technical information about the sterilisation of water at Lille, but we remember that at the congress held at Liége in August last, Dr. Marmier said that the sterilisation at Lille did cost 2 centimes per cubic metre. This is rather expensive, considering that the number of microbes in the Lille water is not very high—1,000 to 3,500 per cc.

Not much account, if any, must be taken of the quantity of ozone calculated in milligrammes per litre of air. This yield of ozone depends too often on the method adopted for its determination, and, as a matter of fact, it is immaterial whether the polluted waters are sterilised at a rate of 6, 5, or 4 milligrammes of ozone. What municipal bodies, brewers, manufacturers of aerated waters care for, is the cost of this sterilisation per metre cube of 220 gallons.

This is why in the experiments of ozonisation of water which I have been carrying out since three months at my laboratory, I have completely neglected the yield of ozone as a factor and adopted the calculation in watt-hours of the cost of ozonisation of waters, differently and more or less contaminated.

What is the flow of water? What is its contamination? Does it take 1 watt or less to purify 1 gallon? How many watts per cubic metre (= 220 gallons)? This is what guided me in adopting the methods I have followed in my researches, and I think it the right one, and the most reliable.

My installation, which is more than modest, does not allow me treat more than 440 gallons (2 cubic metres or tons) of water per hour, which flows through five small tanks at the rate of 50 gallons in 7, 8 or 10 minutes. A Root's blower forces the ozonised air under the perforated bottom of the first tank, wherefrom mixed with the water, it circulates through the other tanks.

The ozoniser is rather small; on an average the volts in the primary circuit vary between 40 and 60, and the amperes between 3 and 5. The tension in the secondary does not exceed 3,500 volts. The water which I treated was artificially contaminated by addition of sewage or of cultures of resisting microbes such as the Fluorescens Liquefaciens Bacillus or the Coli Communis Bacillus; it, therefore, was much more difficult to purify, and generally contained a greater quantity of organisms than the usual river water.

My installation is very imperfect, because it has not been possible in such premises to erect the pump which is required for the purpose, and to have a large tank or a sufficient number of tanks where the contact of water and ozone would be intimate and regular, thus ensuring the absorption of ozone.

My object in making these experiments was not to sterilise a certain sort of water of a given degree of impurity, but to apply ozone to waters containing sometimes an enormous number of micro-organisms, and which resemble more diluted sewage effluent than drinking water.

The results I have obtained demonstrate the powerful action of ozone as a germicide, and they allow to calculate, according to the degree of impurity of the water, the amount of electrical energy which has to be spent in order to completely destroy the germs which pollute it.

I must add that the bacteriological examination of water before and after treatment, was made every day by a specialist from January to April 15th.

A glance at the following table, where I have entered the most interesting results, &c., will give an idea of what can be done in an installation erected in such a manner that all the available ozone is utilised for the destruction of the organic matters and of the living organisms:—

Nature of the water.	Watt per gallon.	Watts per 220 gallons.	Micro-organisms per cc.	
			Before.	After.
Water and sewage ...	1·006	221 32	22,000	None
" " ...	1·08	237 6	24,000	10
" " ...	1·08	237·6	22,000	None
" " ...	1	220	18,000	10
" " ...	1 08	237·60	27,000	10
" " ...	1 08	237·6	22,000	None
" " ...	1	220	15,000	40
" " ...	1·44	316 8	3,500	None
" " ...	1·30	286	40,000	None
" " ...	1 30	286	110,000	40
" " ...	0·892	196 24	6,000	None
Coli Communis B. ...	0 76	167 2	40,000	40
"	0 692	152·24	50,000	None
"	0 8	176	14,000	None
"	0·8	176	13,000	20
"	0 8	176	11,500	None
Fluorescens Liquefaciens B	0 72	156 4	7,000	None
Coli Communis B. ...	0 73	166	3,000	10
"	0·73	166	2,600	10
"	0 67	147·4	3,600	10
"	0 64	138	13,000	None
Coli Communis and sewage	0 64	138	16,000	10
" " " "	0 64	138	15,000	40

The agitation of water, *i.e.*, its bubbling with ozone, has been in most cases far from satisfactory, and this has often prevented the ozonisation from having its full efficiency. The passage of the water being rapid, a large proportion of the ozone instead of being completely absorbed escaped from the last tank. This means that the number of watts was considerably below the one shown in the table. I do not think I spend on an average more than 140 watt-hours per cubic metre of water which is not too much polluted.

I feel convinced after this long series of careful experiments that, in a model installation on the Thames banks, at a place where the water is not too much charged with organic matters and micro-organisms, and with an improved system of tanks and pumps, which I need not describe here, it is possible to demonstrate on a practical scale that the purification and complete sterilisation of water can be effected at the rate of 100 watt-hours and less per cubic metre (220 gallons) of water, or 2,200 gallons per kilowatt-hour.

There was a time, and that not many years ago, when wise men laughed scornfully at the dreamers whose researches had for object the electric lighting of London and other large cities. The dream has become a reality, and so will soon be the destruction by ozone of the infectious germs which swarm in the water we drink.

Since writing this article, I have received the report of a well-known London bacteriologist who, on the 14th ult, was present at my experiments and took some samples of water which, on examination six days afterwards, gave the following results, which he finds very satisfactory:—

80 gallons of tap water + $\frac{1}{10}$th broth cultivation of the Bacillus Coli Communis.

	Bacteria.	Coli per cc.
Control	1,070	1,050
Tank 4 (after ozonisation) ...	20	0
Tank 5	0	0

80 gallons of tap water + $\frac{3}{10}$ths broth cultivation of the Bacillus Coli Communis.

	Bacteria.	Coli per cc.
Control	4,000	Majority.
Tank 4 (after ozonisation)...	20	0
Tank 5	10	0

THE CROWDUS ACCUMULATOR.

In the construction of pasted plates, it has not been an uncommon desire on the part of inventors of accumulators to obtain a grid which, while giving a maximum amount of surface, possessed considerable mechanical strength. Generally speaking, a robust type of plate is almost synonymous with weight, and though countless efforts have been made,

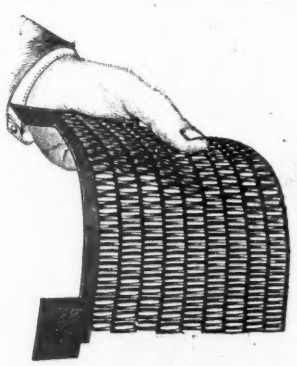


Fig. 1.

and are being made, to produce a light plate, the necessity for mechanical strength has hitherto blocked the way. Supposing, however, one were to sacrifice mechanical strength, and rely on a grid that was weak! The obvious answer is that we should lean on a broken reed.

It is a curious, not to say an audacious proposal, but it is not altogether new; for quite early in the history of the motor car boom there was a suggestion made that if a battery were adopted which had a short but efficient life, electric vehicles might achieve success. There is probably some reason in the assertion, and like a good many other electrical proposals, it only requires somebody with a scientific spirit and a long purse to test the truth of the theory.

Last year we described in these columns* a type of American accumulator—the Crowdus—which has since become Anglicised to the extent of being manufactured in this country under the ægis of the inventor, Mr. W. A. Crowdus.

We have recently had an opportunity of inspecting the process of manufacture carried on at Bridge Place, S.W., by the Crowdus Accumulator Syndicate, Limited, and though the mere factory operations do not materially differ from those of other accumulator makers, the cell itself possesses unusual features and justify us alluding to them again. The greatest

* Electrical Review, March 18th, 1898.

departure from existing practice which the Crowdus accumulator presents is the use of a grid which is mechanically weak, the presumption being that it is unnecessary to have a grid which lasts longer than the paste. In the description published by us last year it was stated that the inventor claimed to have discovered "that the hitherto damaging

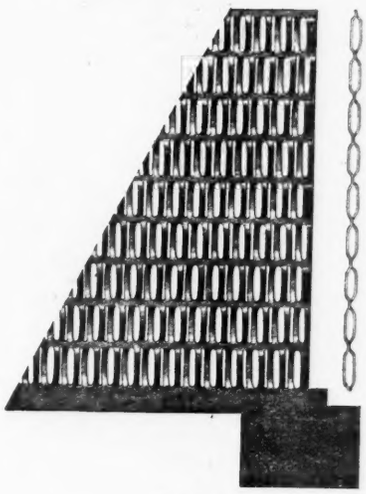


Fig. 2.

results from the expansion of the lead salts of positive plates can be turned to good effect by using a thin or mechanically weak rolled lead conducting support which is free to expand under pressure from the salts, but has its expansion directed principally in straight lines parellel with the face of the plate, that is, the plate may stretch equally in all directions so that there is no tendency to buckle."

Primarily, then, this sheet lead having no greater thickness than ·037 to ·039 inch, is employed, and this is passed through a special form of punching machine which produces elongated perforations. The character of the plate as well as its flexibility is shown in figs. 1 and 2, the plate after pasting presenting the appearance shown in fig. 3. Terminals are left on each plate, whether of the positive or negative type, and when assembled together, are in the form shown in fig. 4. The paste, consisting of sulphate of lead and litharge in certain definite

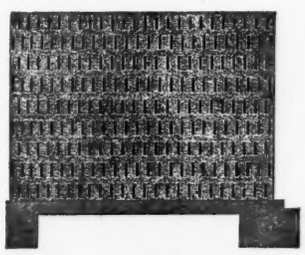


Fig. 3.

proportions, is rubbed in by hand, and after being dried, the plates pass to the forming room. Both positive and negative plates are made up in the same manner, but should there be any variation in the weight, the heavier ones would be used as positives. The method adopted in forming the plates does not differ materially from that alluded to when this accumulator was described in these pages, the chief point being the comparative speed with which the forming process is carried out. A wrapping, or envelope of cellulose, which is formed from wood pulp, is fixed round each plate, and in addition a perforated sheet, possessing high absorbent qualities, is placed between the plates, and the whole being assembled together, presents a firmness that one would scarcely expect from a plate which was primarily weak. The details connected with the production of Crowdus cells appear to have been well considered. The containing case, usually of ebonite, is excellent, and one ought not to omit some mention of the connectors, which are vastly superior to those commonly employed in accumulator work. They consist of bundles of fine copper wire, the ends of which are cast into a special form of terminal, the wires being then insulated by pure rubber.

Judging from the types of cells we have seen, and speaking without any knowledge of their performances after

Fig. 4.

lengthened periods, there appears to be considerable chance that the Crowdus accumulator will achieve success, especially as the inventor intends it only for motor car and similar purposes.

NEW PATENTS AND ABSTRACTS OF PUBLISHED SPECIFICATIONS.

NEW PATENTS.—1899.

Compiled expressly for this journal by W. P. Thompson & Co., Electrical Patent Agents, 322, High Holborn, London, W.C., and at Liverpool, Manchester, and Birmingham, *to whom all inquiries should be addressed.*

8,012. "Economic carbon for electric arc lamps, electric furnaces, or the like." M. P. MacInnerny. Dated April 17th.

8,015. "Improvement in electric incandescent lamps." F. Harrison. Dated April 17th.

8,022. "An improved form of plate for electric accumulators." C. T. J. Oppermann. Dated April 17th.

8,039. "An improved polarised telegraphic relay." A. L. Shepard. Dated April 17th.

8,040. "Improvements in dynamo-electric machines." A. F. Berry. Dated April 17th.

8,044. "Improvements in metallic conduits for electric wires." E. T. Greenfield. Dated April 17th. (Date applied for under Patents, &c., Act, 1883, Sec. 103, December 12th, 1898, being date of application in United States.) (*Complete.*)

8,045. "Improvements in and relating to the manufacture of armoured electric cables." E. T. Greenfield. Dated April 17th. (Date applied for under Patents, &c., Act, 1883, Sec. 103, December 15th, 1898, being date of application in United States.) (*Complete*)

8,052. "Improvements in means for controlling electric circuits, which will allow a circuit to be broken and completed from another circuit." H. Edmunds. Dated April 17th.

8,053. "A new or improved device for automatically effecting the breaking of an electric circuit after a predetermined time." H. Edmunds. Dated April 17th.

8,054. "Improvements in or connected with what are known as dry air insulation electric cables or conductors." H. Edmunds. Dated April 17th.

8,056. "An electric current controlling handle for use in motor cycles, carriages, and automotor cars." E. Hermet. Dated April 17th.

8,060. "Improvements in electrical furnaces." D. Lance, R. L. E. de Bourgade, and L. Schmitz. Dated April 17th. (*Complete.*)

8,065. "Improvements in electrolytic apparatus and processes." A. Dittmar. Dated April 18th.

8 074. "Improvements in making of joints in connecting electricity distribution boxes and cables." T. A. Mackereth, jun. Dated April 18th.

8,075. "Improvement to an electrical double-pole fused lamp post (or bracket) water-tight switch to prevent fusing of main fuses." F. Carter. Dated April 18th.

8,078. "Improvements in electric arc lamps." H. H. Hall. Dated April 18th.

8,097. "Improvements in apparatus for regulating the arc in electric arc lamps." P. N. Chatterley. Dated April 18th.

8,104. "Improvements in or relating to electric furnaces for the manufacture or production of carbide of calcium and other metallic oxides." J. A. Starley and J. Bastick. Dated April 18th.

8,140. "Improvements in electricity meters or measuring apparatus." Siemens Bros. & Co., Ltd. (Siemens & Halske, Aktiengesellschaft, Germany.) Dated April 18th. (*Complete.*)

8,156. "An improvement in electro-magnets." A. L. A. C. d'Arlincourt. Dated April 18th.

8,168. "Improvements in mounting incandescing electric lamp bulbs." H. Moul and A. Lind. Dated April 18th.

8,171. "Improvements in telephones." E. Wilson, C. J. Evans, and H. Godsal. Dated April 18th.

8,172. "Improvements in electric railway systems." H. B. Cox. Dated April 18th.

8,174. "Improvements relating to electro-motors." G. Blanch, A. P. B. Loftus, and K. R. Stuart. Dated April 18th.

8,183. "Improvements in thermo-electric generators." R. Kennedy. Dated April 19th.

8,188. "Improvements in rheostats or electric resistance switches." J. Mabr, W. C. Laidler, and the Sunderland Forge and Engineering Co., Ltd. Dated April 19th.

8,191. "Improvements in wireless telegraphy." A. C. Brown. Dated April 19th.

8,192. "The joining together of the various parts of lightning conductors by electro-deposition." A. J. Hands. Dated April 19th.

8,223. "Improvements in apparatus for testing and firing electric primers and testing batteries and cells." G. C. Fraser and G. K. B. Elphinstone, of the firm of Elliott Bros. Dated April 19th.

8,240. "Improvements in safety devices for use in connection with electrical distributing systems." G. W. Partridge and The London Electric Supply Corporation, Limited. Dated April 19th.

8 243. "Improvements in or relating to electrical arc lamps." F. J. Barberowski. Dated April 19th.

8,287. "Improvements in electric wire conduits." D. H. Shuttleworth-Brown. Dated April 20th.

8,296. "Improvements in apparatus connected with telegraphic signalling." J. A. Fleming. Dated April 20th.

8,302. "Improvements in and relating to kettles and like vessels for heating liquids by the aid of electricity." C. W. Cohen. Dated April 20th.

8,312. "Improvements in resistance coils." Cowan's, Ltd., E. W. Cowan, and A. Still. Dated April 20th.

8,325. "Improvements in electric railways." R. Lundell. Dated April 20th. (*Complete.*)

8,340. "Improvements in electric welding or metal working apparatus." A. F. Berry and R. J. Wallis-Jones. Dated April 20th.

8,358. "Improvements in electric storage or secondary batteries." J. T. Niblett and M. Sutherland. Dated April 21st.

8,360. "Improved electrical device for controlling the pressure of small currents." F. W. Smith. Dated April 21st.

8,365. "An improvement in connection with electric fuse cut-outs." J. G. Childs. Dated April 21st.

8,399. "Improvements in electricity meters." C. D. Abel. (Société Anonyme Continentale pour la Fabrication des Compteurs a Gaz et Autres Appareils, France.) Dated April 21st.

8,468. "Improvements in arc lamps." E. W. Bohle, H. Bohle, and J. A. Phillips. Dated April 22nd.

8,482. "Improvements in alternating current motors." M. Deri. Dated April 22nd. (*Complete.*)

8,483. "Improvements in electrical signalling apparatus." E. Lavens and E. J. Lavens. Dated April 22nd.

8,497. "Improvements in bulbs for electric incandescence lamps." C. Bartenstein. Dated April 22nd.

8,498. "Improvements in electric elevators." E. H. Johnson. (G. Rennerfelt, U.S.) Dated April 22nd. (*Complete*)

8,505. "Improvements in or connected with the application of electro-motors to propulsion." W. T. Carter, J. A. Dawson, and T. Gray. Dated April 22nd.

ABSTRACTS OF PUBLISHED SPECIFICATIONS.

Copies of any of these Specifications may be obtained of Messrs. W. P. Thompson & Co., 322, High Holborn, W.C., and at Liverpool, Manchester, and Birmingham, *price, post free*, 9d. (*in stamps*).

1897.

1,756. "Improvements in double contact switches, especially adapted to telephones." M. Byng and F. G. Bell. Dated January 22nd, 1897. Switches specially adapted for telephones are constructed with a pivoted tapering lever, having at its thin end a spring and platinum contact, which plays between and rubs against the stops. The lever is mounted on a spindle, to which one end of a coiled spring is attached, the free end of the spring being connected electrically to some part of the frame. In the case of telephones, the switch is mounted on the transmitter, and the lever is operated by placing the receiver in or removing it from a slotted holder. 2 claims.

2,710. "Improvements in the method of and apparatus for the electro-deposition of copper and other metals on rotary madrels." W. E. Heys. (E. Dumoulin, France.) Dated February 2nd, 1897. Consists of improvements in the process and apparatus described in Specification No. 16,360, A.D. 1895. Within the vat is the rotary cathode, surrounding which is the anode. In the form described the anode is supported between two perforated or pervious walls of aluminium gauze or sheet of perforated celluloid, &c., which rest upon the edges of the vat and are kept apart by flanges. In another form transverse aluminium bearers are perforated with two rows of holes in the upper parts and with one row in the lower, through all of which are passed longitudinal wooden rods; over these rods are placed a woollen sheet, aluminium gauze, perforated aluminium, sheet celluloid, &c. The two end bearers have flanges to prevent the anode material falling over the edge. The anode may consist of Rio Tinto precipitate or granular metal, which can be fed in at the top as it is consumed and falls to the bottom. In addition to obtaining a copper or other metal deposit an alloy may be obtained. Thus, to obtain an alloy of copper and aluminium, aluminium may be mixed with the copper anode, or a sulphate or other aluminium salt added to the copper sulphate electrolyte. The cathode may be a copper mandrel coated with India-rubber solution and then with plumbago, whereby the formed tube may be easily withdrawn, especially if the cathode be made slightly conical. The electrolyte is kept down to 60° F. by cooling pipes arranged in any of the vessels through which the electrolyte is circulated. The electrolyte is purified by blowing air thereinto, by adding copper oxide or potassium permanganate, and by filtering. The filtering takes place in a series connected together, so that any one of them can be cut out without interfering with the others. The liquid, after entering, passes out after passing through a filtering medium, as woollen fabric, stretched over the underside of a wooden framing. The "impregnators" described in the above-mentioned specification are preferably reciprocated, so that any point describes paths having angles of about 45° to the axis of the cathode. 7 claims.

2,996. "Improved apparatus for automatically starting electric fire pumps and other electrical machinery." T. Rungay. Dated February 4th, 1897. Relates to an operating mechanism for an electric switch for starting electric fire pumps and other machinery. The switch arm is turned by the descent of a heavy weight attached to a chain passing round a pulley on the axis of the switch. The switch is held open by a detent lever, which holds down the light weight on the other end of the chain. This weight is attracted by an electro-magnet when its circuit is closed either by a thermometer or by a press button. The end of the lever is then raised by a spring, and the circuit of the electro-magnet being thereby broken, the weight can descend and close the switch of the electro-motor circuit. Resistances serve to graduate the current turned on. In the provisional specification, it is stated that the switch may be used for turning on electric light by closing the electro-magnet circuit by clockwork. 2 claims.

3,727. "An improved magnetic toy." J. H. Homeister. Dated February 11th, 1897. A ball, wheel, roller, or the like, is caused to rotate and in most cases to also travel along the ground, &c., while a figure remains on or near its highest point. The ball is provided with a divided shaft, fixed thereto by supports. Freely suspended from the shaft is a frame carrying a loose vertical shaft upon which a magnet is fixed, a comparatively heavy weight, which is eccentrically supported, and a motor spring case which can be wound up by a key inserted through an opening and which is prevented from unwinding with a ratchet wheel and pawl. A friction disc or toothed wheel on the spring barrel drives a friction disc or pinion on the shaft, and, therefore, causes the ball to roll and the portion of the shaft also to rotate. From the latter motion is communicated by friction or toothed wheels, worm wheel and worm to the shaft and magnet. This induces magnetism in the armature above, upon which is fixed, or simply rested, any desired appliance, as a velocity and rider, a swinging arm, a figure on a ball, a disc, a balloon, or a top. By disconnecting the shaft from the ball, the latter simply rotates without travelling. 4 claims.

3,772. "Improvements in portable electric lamps for use in mines and other places." S. F. Walker. Dated February 12th, 1897. A portable lamp, for miners' or other purposes, consists of an incandescent lamp mounted in a glass cylinder on the screw cover of a metal casing containing two single fluid galvanic cells, which are connected in series to the lamp. The cells are of equal capacity, and arranged so that the electrodes of one can revolve round the other in screwing on the cover which carries them. The construction may be similar to that described in Specification No. 22,443, A.D. 1895. In the form illustrated the cell of vulcanite or other insulating material is divided to form an annular upper portion serving as the second cell. The cover consists of a screw ring and insulating discs, with an intervening layer with a mixture of resin and Portland cement or plaster of Paris in equal quantities, with a little oil or grease. Perforated carbon cylinders impregnated with sulphur are connected to flange metal rings set in the disc. They contain insulating discs carrying the brass supports of zinc rods. The zinc in the annular compartment is connected directly to a central contact for a screw-capped lamp, which is carried in a metal holder. The glass cylinder is held by a metal cover plate and bolts. The glass cylinder may be partly reflecting. The cover carries a handle. 5 claims.

6,743. "Improvements in electric accumulator plates." A. H. Mayes. Dated March 15th, 1897. The plates are made of lead wire woven or otherwise made into gauze. In use, each plate may be enclosed in a perforated case of celluloid, vulcanite, woodite, &c., or plates of these materials may be placed between them. 2 claims.